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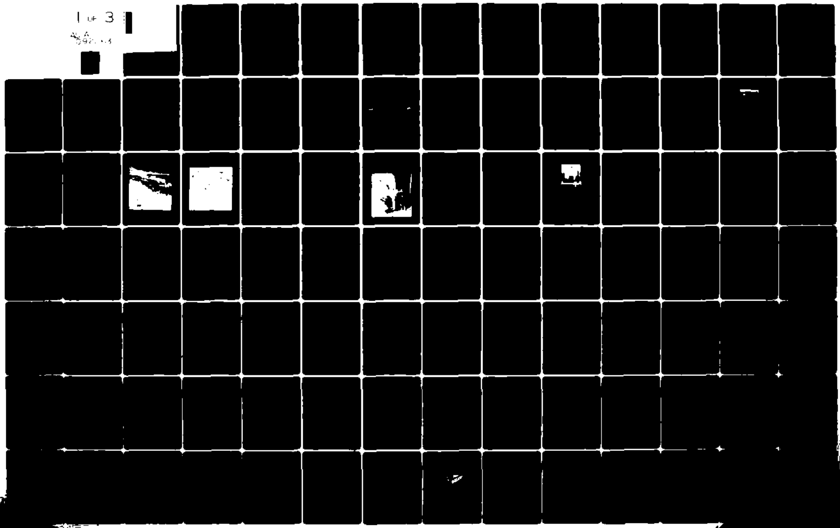

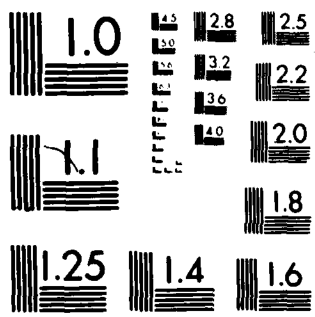

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The intent of this three-year research program has been to evaluate detection and recognition processes as observers view dynamic sensor imagery for target acquisition purposes. Moreover, we have attempted to specify differences in human performance which can be attributed to inherent differences between IR and TV target signatures. In all experiments, we have emulated the image dynamics associated with a ground-stabilized, narrow FOV sensor. Further, we have used experienced observers as subjects in these experiments. The

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operational characteristics of certain attack aircraft and imaging missiles led us to examine initial slant ranges to target of 30,000, 15,000, and 5,000 ft. Comparisons of operator performance with simulated IR vs. TV imagery at all initial slant ranges indicated that IR targets were detected more quickly and at greater stand-off ranges than comparable TV targets, especially when targets were embedded in background scenes of medium or high complexity. This occurred even though we simulated optimal visibility conditions, with no significant atmospheric attenuation or distortion of the energy received by the imaging sensor.

For the 5,000 and 15,000 ft. starting slant ranges, the displayed images of the targets at the beginning of each trial subtended approximately 2 degrees 10 minutes and 45 minutes of visual arc, respectively. Detection occurred very rapidly, and the targets at those points in time were of sufficient size to be recognized almost immediately. In the case of the 30,000 ft. starting slant range, however, appreciable time delays were found between detection and recognition responses. This was due to the fact that, following detection, the operator had to continue observing the target until the range between the sensor and its aimpoint was reduced sufficiently to achieve the necessary image detail for recognition.

The data from the 30,000 ft. experiment permitted examination of an important issue with regard to the effectiveness of IR "hot spots" as an aid to the target acquisition process. That is, we were able to determine whether a FLIR image of an active target merely provides contrast enhancement which reduces visual search time during detection, or whether the distribution of luminance differences within the target provides a potent spatial cue for recognition as well. If it is assumed that "hot spots" facilitate detection only, then the operator must depend principally upon differences in contour, shape, and internal detail to distinguish among quite similar tactical targets. Additionally, if the image quality and scale are the same for both sensor systems, as was the case in this simulation, then the range to target at recognition should be virtually identical whether the targets are imaged by an IR or by a TV sensor. This did not occur in our experiment; rather, the stand-off ranges associated with recognition were greater for IR than for TV targets. Therefore, it was concluded that the luminance distributions within the different targets served as an important cue for recognition, and this was confirmed independently when the performance data were subjected to a stepwise multiple regression analysis to identify those factors having the greatest impact on target detection and recognition.

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DYNAMIC TARGET ACQUISITION: EMPIRICAL MODELS OF OPERATOR PERFORMANCE

29 AUGUST 1980 **MDC E2305**

FINAL REPORT

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FRANK E. GOMER

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THE RESEARCH DESCRIBED HEREIN WAS SUPPORTED BY THE AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

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PREFACE

This report presents the results of a three year program of research designed to examine target acquisition performance of observers viewing dynamic sensor imagery. The first phase was devoted to mission and operations analysis, a review of the variables influencing target acquisition performance, and the definition of experimental procedures. Data collection, analyses, and operator performance modeling were completed during phases two and three. The program, sponsored by Dr. Alfred R. Fregly, was conducted by the McDonnell Douglas Astronautics Company - St. Louis Division for the Air Force Office of Scientific Research under contract F49620-77-C-0100. Mr. William N. Kama of the Air Force Aerospace Medical Research Laboratory served as Technical Monitor. Dr. Frank E. Gomer and Dr. Larry R. Beideman of the McDonnell Douglas Astronautics Company - St. Louis Division were Program Manager and Principal Investigator, respectively.

1.0 INTRODUCTION

One of the most immediate and demanding requirements for tactical aviation is a day/night, all-weather attack capability against mobile, tank-size targets operating within heavily defended battle zones. To meet this requirement, imaging sensor systems must be incorporated for target detection/recognition (Ory, Schaffer, Jaeger, and Kishel, 1975). Because of the nature of the targets and the surrounding terrain, feature extraction and image enhancement by computer are not sophisticated enough at the present time to provide a fully automated target acquisition system.

It follows, then, that the effectiveness of an imaging sensor must be defined in terms of the success with which an operator is able to identify targets that are displayed on cathode ray tubes (CRTs). A great deal of information is available concerning the perception of displayed imagery when normal- or low-light-level television (TV) sensors are used (Barnes, 1978; Erickson, 1978; Jones, Freitag, and Collyer, 1974). However, all-weather considerations for imaging systems have clearly established the need for additional data relating operator performance to infrared (IR) sensor presentations.

While TV sensors function within the visible portion of the electromagnetic spectrum, IR sensors are responsive to emitted and reflected thermal energy. When the outputs of IR sensors are imaged, luminance distributions within the displayed scene represent thermal gradients across the terrain and target areas. Therefore, unique spatial cues may be available to the operator as he scans the display for potential targets. Consistent with TV sensor systems, however, the detector characteristics and array configurations of the newer IR sensors provide high resolution imagery with excellent detail of a pictorial nature.

The purpose of this three year program has been to study detection and recognition processes as operators view dynamic IR or TV imagery for target acquisition purposes. In the design of our experiments and in the development of our part-task simulation, we have placed importance upon the operational factors which impose limitations upon the utilization of sensor systems during attack missions. Moreover, within the context of our simulation techniques, we have attempted to specify performance differences which can be attributed to inherent differences between IR and normal-light-level TV target signatures. The first year was devoted to outlining a realistic mission scenario, reviewing the pertinent literature to identify the variables affecting target acquisition performance, and defining a research program to examine basic perceptual processes related to dynamic target acquisition. The execution of the experimental plan and the analysis of the data were completed during the second and third years. Also, an empirical model of dynamic target acquisition was generated during the final year.

The philosophy we have followed throughout is that basic research programs which seek to interpret or model complex perceptual judgements must include investigations that adequately represent the dynamic display conditions encountered by operators of actual imaging systems.

1.1 MISSION SCENARIO

In order to provide a realistic simulation of an interdiction mission, a set of boundary conditions was established that considered probability of mission success and aircraft survivability, especially with respect to such variables as range-to-target and altitude. The maximum range at which an operator can acquire a target is a function of target size and sensor capabilities. Aircraft altitudes, which allow successful target acquisition, are limited by terrain masking, cloud cover, and antiaircraft defenses.

1.1.1 Basic Mission Assumptions - A heavily defended European theatre and Eastern Block adversary were assumed. (Refer to Figure 1-1 for targets of opportunity.) Air missions were to be flown against individual tanks and support vehicles which exhibited a range of thermal activity from hot (operating and firing) to cool (parked and inactive). Aircraft were directed to known geographical areas saturated with targets. While the battle zone was designated free-fire, weapon release was dependent upon accurate target classification. Air cover was assumed to eliminate air threats during the air-to-ground strike phase of the mission.

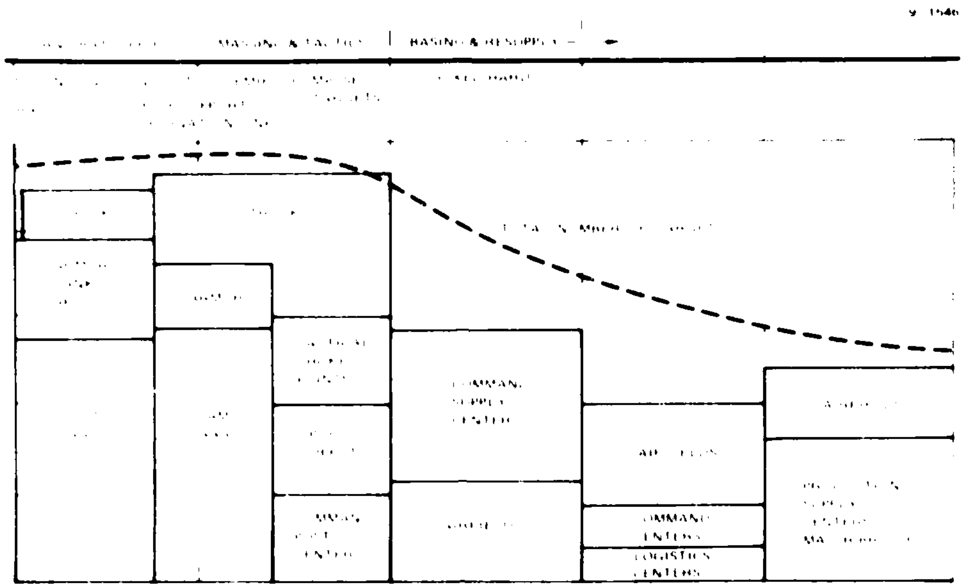

FIGURE 1–1 DISTRIBUTION OF TARGETS BEHIND THE FORWARD EDGE OF THE BATTLE AREA (FEBA)

1.1.2 Aircraft Operational Flight Envelope - Researchers and engineers have tried to develop techniques for decreasing the vulnerability of attacking aircraft to the formidable defensive array presented by modern antiaircraft weapons. Stand-off range is one of the most important factors in determining the survivability of an attacking aircraft (Levine, Beideman, and Youngling, 1978). For example, the range of the Soviet ZSU-23-4 antiaircraft artillery is 2500 meters (Pretty, 1977). If an aircraft can accurately deliver ordnance beyond this range, one of the major low-level air defense systems would be neutralized.

Analysis of air defense systems also has shown that tactics which include high speed, low-altitude penetration contribute significantly to survivability (Maney, 1973; Tobin, 1976; Transue, 1971). Tactics, developed for the A-10 during exercises in Europe, indicate successful implementation of a low-altitude ingress with altitudes as low as 100 feet (Brown, 1977). With low-altitude approaches, pop-up maneuvers (see Figure 1-2) are required to achieve an unmasked line-of-sight to the target and for delivery of certain types of ordnance.

Environmental constraints of weather and terrain masking present the most severe restrictions on the flight profile. Analyses of terrain masking in the European theatre have shown that an altitude of at least 5000 feet is required to

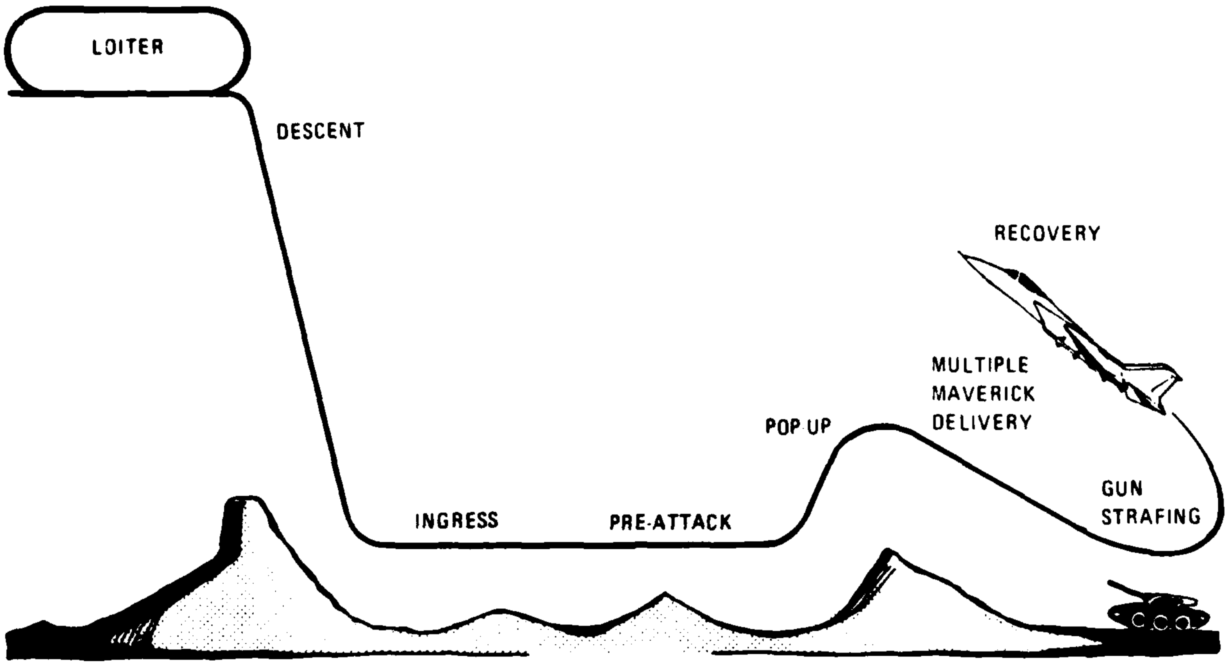

FIGURE 1–2 POP-UP MANEUVER DURING PRE-PLANNED INTERDICTION MISSION

obtain a clear line-of-sight to the target at a 30,000 foot slant range (see Figure 1-3). Weather data (see Figure 1-4) indicate that this altitude will be below the yearly average ceiling approximately 65 percent of the time (using the average for Germany).

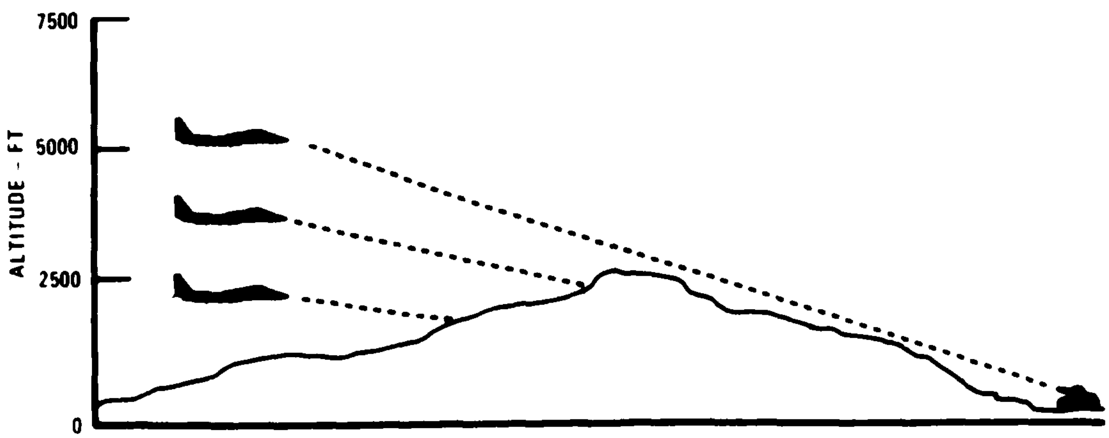

FIGURE 1–3 TERRAIN MASKING AS A FUNCTION OF ALTITUDE

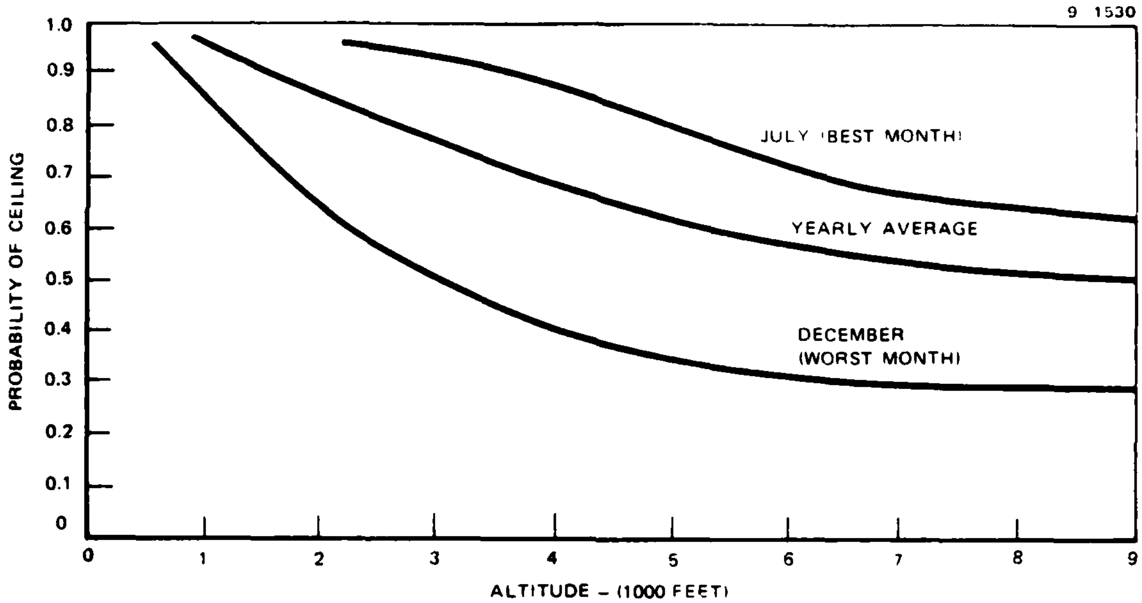

FIGURE 1–4 PROBABILITY OF CEILING FOR GERMANY

1.2 FORWARD-LOOKING SENSOR CONFIGURATION

Forward-looking sensors are typically set at a fixed depression angle or gimballed to track a point on the ground (see Figure 1-5). In the former case, the sensor imagery will move down or across the display as the aircraft travels forward, giving rise to a moving-window presentation. The tracking sensor, on the other hand, will present a relatively stationary image of a ground area since the sensor orientation continuously compensates for the forward movement of the aircraft. A list of differences in image dynamics attributable to these configurations is shown in Figure 1-6. For moving window displays, the image moves across the display at a rate proportional to the speed of the aircraft. Our earlier research with moving-window displays indicated that insufficient time is available for target acquisition at the higher aircraft velocities (Levine and Youngling, 1973). In fact, with some flight profiles, less than three seconds are available to acquire a target on the display. A stabilized-image presentation, on the other hand, reduces the time-on-display problem, but it may create new problems from a perceptual standpoint. Assuming a fixed field-of-view (FOV), successively smaller terrain areas are imaged on the display as the aircraft approaches the target location. The observer must search a display in which the scene appears to be expanding outward as the objects on the ground are being imaged at a progressively larger scale. In addition, targets offset from the

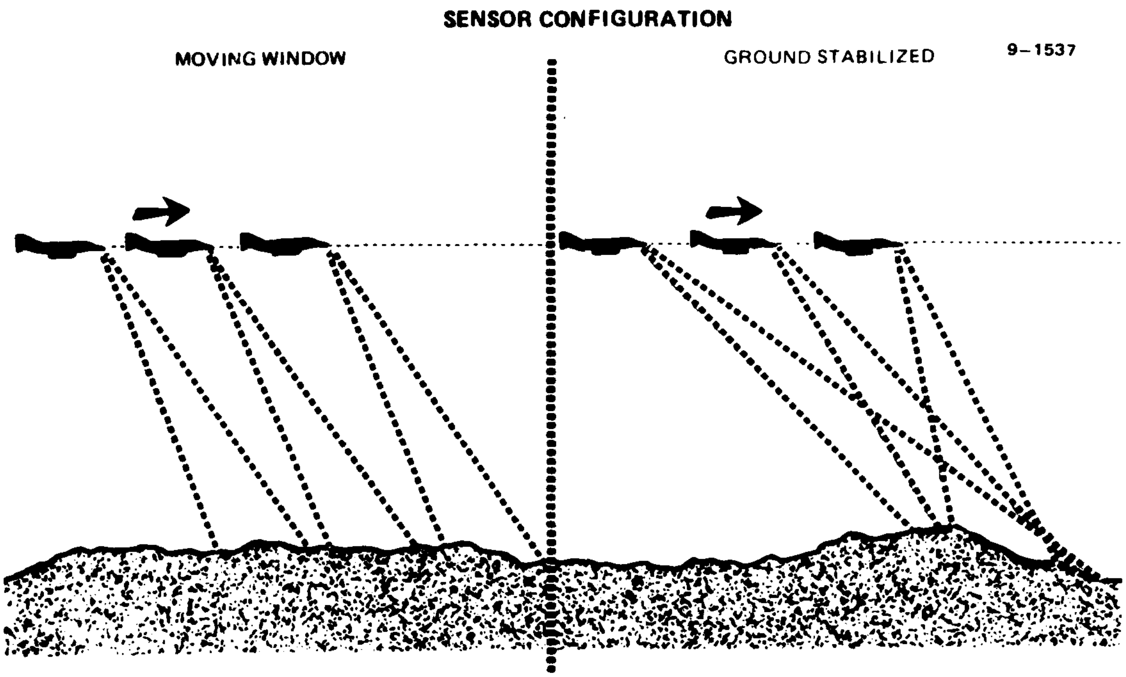

FIGURE 1–5 FORWARD-LOOKING SENSOR CONFIGURATIONS

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VARIABLE	SENSOR CONFIGURATION: MOVING WINDOW	SENSOR CONFIGURATION: GROUND STABILIZED
IMAGE/TARGET	SCENE-TARGET MOVES ACROSS DISPLAY	FIXED SCENE/TARGET MOVES FROM CENTER TO OUTER EDGES – ZOOM EFFECT
TIME -ON- DISPLAY	PROPORTIONAL TO SCALE AND SPEED – RELATIVELY SHORT	DETERMINED BY RANGE, SPEED AND TARGET POSITION – RELATIVELY LONG
SCALE	RELATIVELY CONSTANT ACROSS IMAGE	VARIES WITH CLOSING RANGE
GROUND AREA TO BE SEARCHED	CHANGES CONSTANTLY	GETS SMALLER AS CLOSING RANGE DECREASES
ASPECT ANGLE	FIXED	CAN CHANGE WITH CLOSING RANGE

FIGURE 1–6 DIFFERENCES IN IMAGE DYNAMICS AS A FUNCTION OF FORWARD – LOOKING SENSOR CONFIGURATION

center of the sensor FOV will migrate toward the edge of the display (see Figure 1-7). Despite the perhaps unfamiliar image dynamics, ground-stabilized sensors can be very effective for target acquisition purposes (Bruns, Wherry, and Bittner, 1970; Bruns, Bittner, and Stephenson, 1972; Levine and Youngling, 1973).

1.3 STUDY VARIABLES

We have assumed a low-altitude penetration followed by pop-up to a higher altitude in order to achieve a clear line-of-sight to the target. Further, a ground-stabilized sensor presentation has been simulated, as well as daytime conditions with optimal visibility.

Stand-off range was identified earlier as an extremely important factor with regard to survivability. Sensor/display systems must be designed to provide sufficient image detail for target identification to occur beyond the effective envelopes of antiaircraft defenses. We have simulated initial slant ranges to target of 5,000, 15,000, and 30,000 feet. These ranges are appropriate for various aircraft and ordnance characteristics, as well as for classes of imaging missiles.

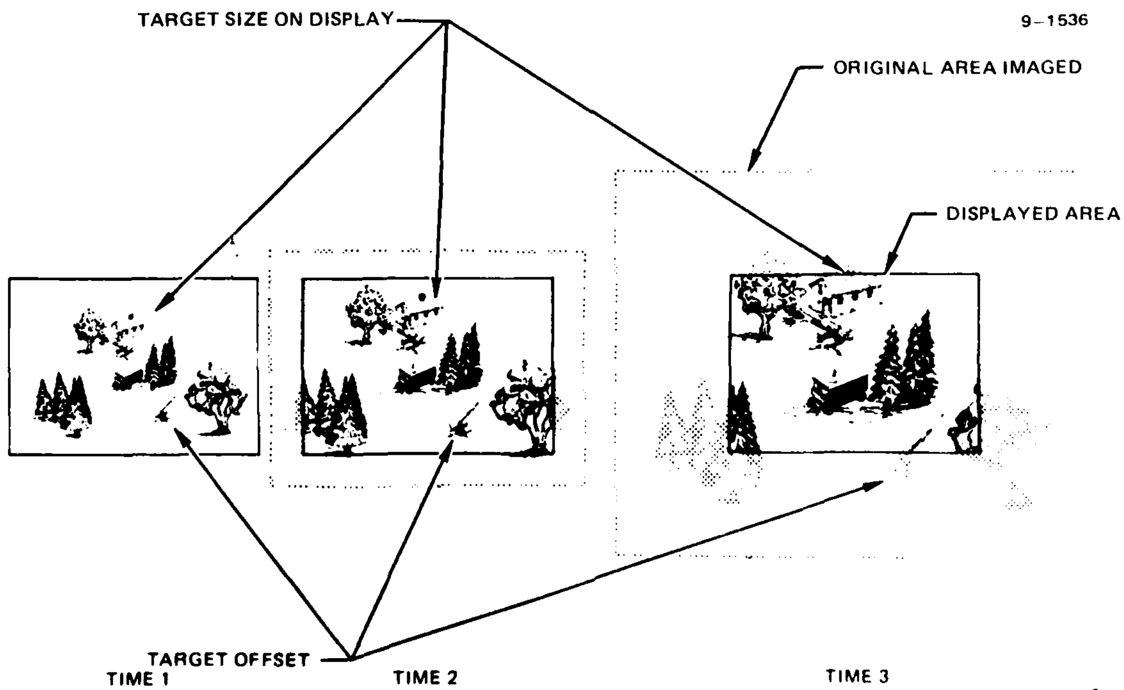

FIGURE 1-7 ZOOM EFFECTS WITH GROUND STABILIZED SENSOR

The specific parameters which were selected for examination in all studies include target type, target signature, background scene complexity, and closure rate.

1.3.1 Target Type - Two important attributes of a target, which influence the design and configuration of sensor systems that are used for target acquisition purposes, are its size and internal detail. A tank, a truck, and a half-track are important tactical targets in the Eastern European theatre. While these targets have different contours and internal details, the similarities with respect to size and chassis provide a moderately difficult target identification task.

For a specific magnification factor associated with the optical elements of an imaging sensor system, target size on the display can be determined from a knowledge of the sensor FOV and depression angle and the slant range to target. Further, for a given sensor depression angle, target size on the display is approximated by the equation:

$$T_S = S_D \left(\frac{S_T}{(R_S) \tan FOV} \right)$$

where: T_S = Target size on display
S_D = Display size
R_S = Slant range
S_T = Target size perpendicular to sensor line-of-sight
FOV = Field-of-View of sensor

As the depression angle approaches 90°, the length and width of the target determines its image size. At small depression angles, the height of the target becomes the major determinant of its image size (see Figure 1-8). A 1.5° sensor FOV was selected to assure sufficient target size and resolution on the display for the slant ranges and the 10° depression angle we have simulated in our experiments.

1.3.2 Target Signature - The term "signature" refers to attributes of the displayed image which are characteristic of a particular target. In the case of IR imagery, we are most concerned with luminance distributions representing

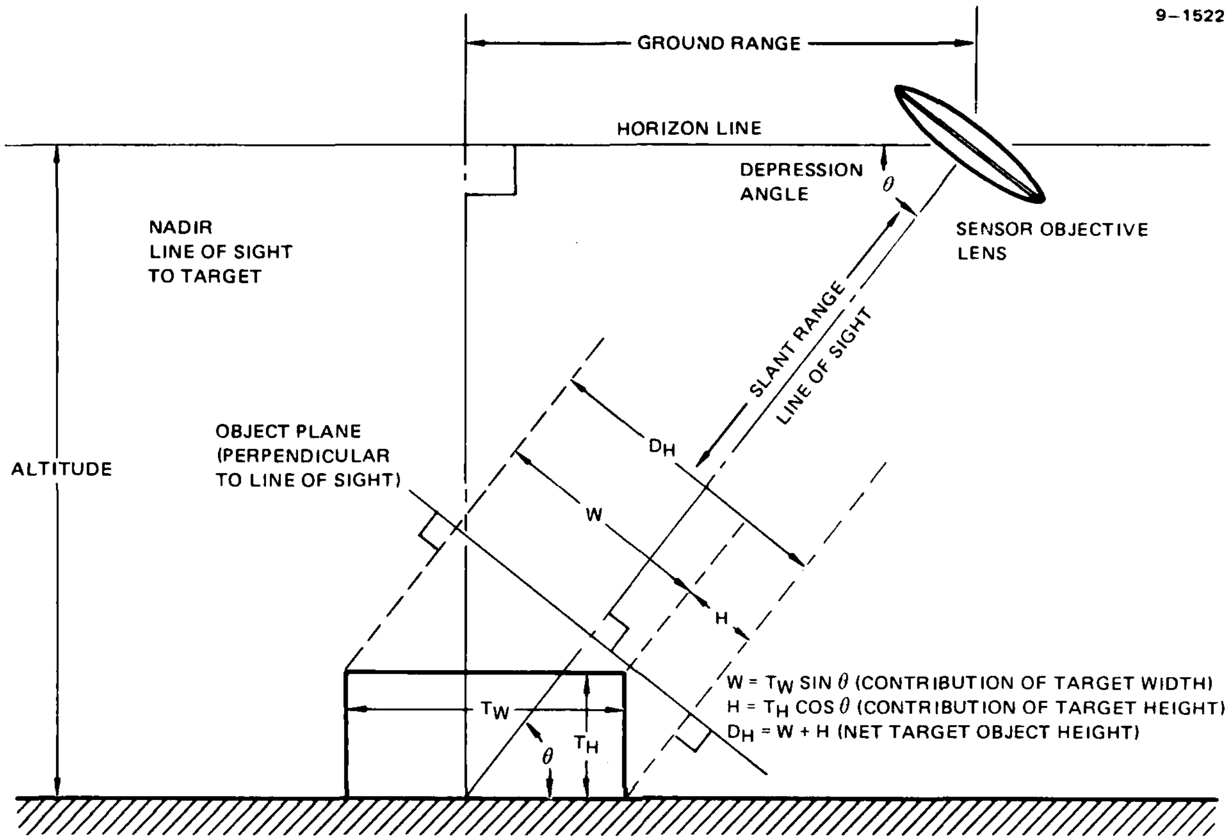

FIGURE 1–8 DETERMINATION OF TARGET IMAGE SIZE

temperature differences between adjacent areas of the target and between the target and the immediate background. Differential emissivity, internal heating, and friction from moving parts contribute to the thermal pattern of a given vehicle. While ambient temperature, directionality of solar irradiation, humidity, and wind will, in fact, modify these target-specific IR features, the basic thermal pattern remains fairly constant under a variety of conditions.

For these studies, two classes of IR signatures were required, representing both active and inactive vehicles. The active targets were modeled after vehicles which recently had been traveling and the corresponding signatures showed the typical "hot" cues of luminous engines and treads/or wheels. Inactive vehicles, on the other hand, while retaining some heat, were assumed to exhibit temperatures which were more similar to those of the background areas. In addition to the two classes of IR signatures, we included a third target signature which was representative of normal-light-level TV imagery (see Figure 1-9).

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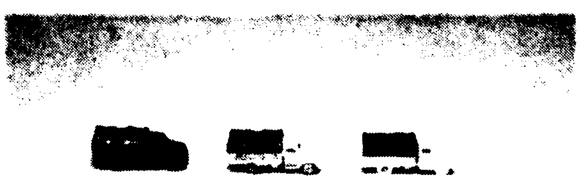
TELEVISION | INACTIVE TARGET FLIR | ACTIVE TARGET FLIR

TANK

TELEVISION | INACTIVE TARGET FLIR | ACTIVE TARGET FLIR

HALF-TRACK



TELEVISION | INACTIVE TARGET FLIR | ACTIVE TARGET FLIR

TRUCK

FIGURE 1–9 TARGETS AND SIGNATURES USED IN ALL STUDIES

The displayed target signatures can be modified by the sensor and display electronics. Brightness and contrast adjustments can dramatically change the luminance distributions within the target and the background. Also, extreme temperature signals will cause the sensor system to alter its gain and mode of response, and as a result, all lower temperature regions will be imaged as nondiscriminable dark areas. Observers often manipulate display contrast directly to achieve this effect and thus maximize the effectiveness of IR "hot spots" as cues in target detection.

1.3.3 Background Scene Complexity - The background in which a target is located significantly affects target acquisition. Clearly, the surrounding terrain within the displayed image constitutes a particularly potent source of interference. The terrain may contain complex, clutter objects which share similar perceptual features with the target - features such as size, contrast, or color. The number of common features, the physical proximity of clutter to the target, and the total number of clutter elements interact to influence the difficulty that the observer will experience in extracting the target from the surrounding terrain and in identifying the target quickly.

There is, however, considerable difficulty in defining and objectively measuring background scene complexity. Zaitzeff (1977) refers to ambiguity, the number of possible target areas, and heterogeneity, the variety of feature differences in the background. Both attributes are usually measured subjectively. However, Rhodes (1964), in a study of target detection using air reconnaissance photographs, stated that "... raters were able to make highly reliable and seemingly valid judgements about the complex perceptual characteristics of aerial photographs."

We used a rater judgement technique (with the Zaitzeff criteria) as a means of scaling background scene complexity. Ten MDAC employees, five male and five female, with corrected 20/20 near visual acuity served as subjects. All subjects volunteered and were familiar with aerial photography.

Forty-eight 6 x 7 1/2 inch photographs of the McDonnell Douglas Terrain Map were chosen for rating purposes. The scenes ranged from flat areas with no clutter to areas having almost total tree cover. The photographs simulated a 1.5° sensor FOV, with a 10° depression angle.

The subjects were required to make a judgment of the complexity of the background scene on a five point scale. Three photographs, selected by three experimenters, representing low (1), medium (3), and high (5) scene complexity, were available to the subjects as a reference. Judgements were made by the subjects following an initial review of all photographs.

Photographs were chosen for inclusion in the experiment if they met the criteria of small inter-rater judgmental variance and had assigned values close to one, three, or five. Scenes typical of the three levels of complexity selected for the studies are shown in Figures 1-10, 1-11, and 1-12.

1.3.4 Closure Rate - The closure rates we have simulated (following pop-up) were intended to be representative of the attack velocities of helicopter gunships, fixed-wing aircraft, and imaging missiles. Moreover, since the simulated flight path of the vehicle maintained a constant aspect angle with respect to the target (the vehicle essentially would dive toward the target from the point of maximum altitude), aircraft speed and closure rate have the same value.

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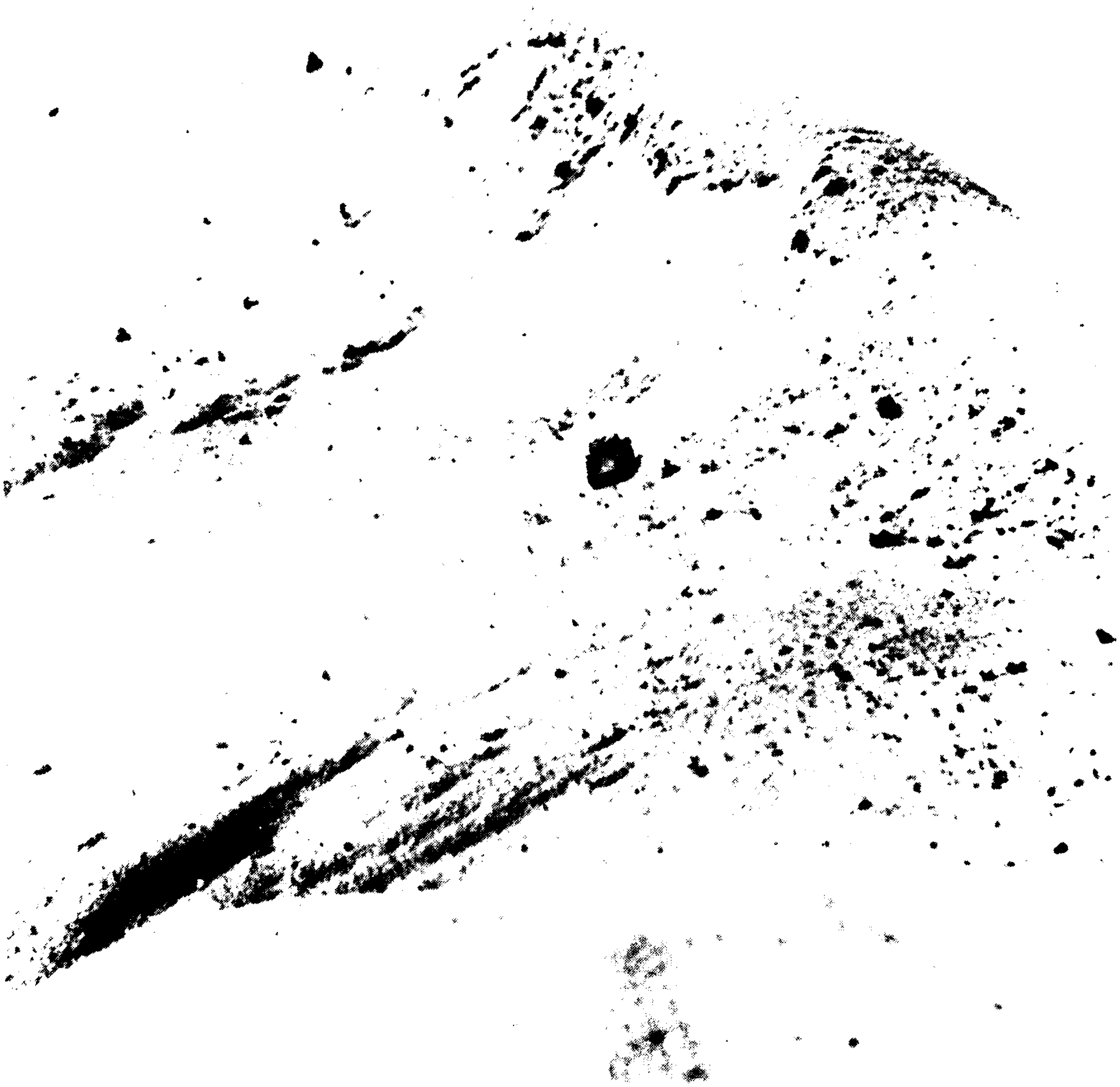

FIGURE 1–10 LOW BACKGROUND SCENE COMPLEXITY

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FIGURE 1–11 MEDIUM BACKGROUND SCENE COMPLEXITY

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FIGURE 1–12 HIGH BACKGROUND SCENE COMPLEXITY

2.0 METHODS

2.1 EXPERIMENTAL DESIGN

The three studies (each referring to a different initial slant range to target) were conducted within the framework of a 3 by 3 by 3 by 3 by N factorial design representing: target signature (active target FLIR, inactive target FLIR, and TV); target type (tank, truck, and half-track); background scene complexity (low, medium, and high); closure rate (250, 500, and 1000 ft/sec); and subjects (N). For each level of background scene complexity, nine distinct terrain areas were incorporated, as depicted in the block diagram of the design (see Figure 2-1). A counterbalancing procedure determined the assignment of specific signatures, targets, and closure rates to a particular terrain area.

Test trials were blocked according to target signature. Thus, all target types, levels of background complexity, and closure rates were presented randomly for a given signature condition before the next signature condition was evaluated. The order in which signature conditions appeared was counterbalanced for the subjects. There were thirty-six test trials for each signature condition. On nine of these trials (three levels of background scene complexity by three closure rates), no targets were presented within the displayed scene.

Dependent measures for detection and recognition included:

- Accuracy
- Response Time (latency)
- Slant Range
- Target Size on the Display

2.2 SUBJECTS

Twelve male college students, involved in a cooperative engineering program at McDonnell Douglas, volunteered to participate in the experiments. The students were 20-23 years of age, with at least 20/20 near visual acuity (Titmus Vision Tester, Landolt C Slides). All subjects participated in Experiment I-5,000 ft initial slant range. The same subjects were randomly assigned to either Experiment II or III (six per experiment), representing a 30,000 or 15,000 ft initial slant range, respectively. The students were administered the Raven Progressive Matrices Test to measure comprehension and reasoning abilities for visuospatial materials. All placed above the 90th percentile.

9–2219

	(BACKGROUND SCENE COMPLEXITY) LOW									MEDIUM	HIGH
	(TARGET TYPE) TANK			HALF-TRACK			TRUCK				
TERRAIN AREA	ACTIVE TARGET FLIR	INACTIVE TARGET FLIR	TV	ACTIVE TARGET FLIR	INACTIVE TARGET FLIR	TV	ACTIVE TARGET FLIR	INACTIVE TARGET FLIR	TV		
1	250*					1000		500			
2		1000		500					250		
3			500		250		1000				
4			250		1000		500				
5	1000					500		250			
6		500		250					1000		
7		250		1000					500		
8			1000		500		250				
9	500					250		1000			

*AIRCRAFT SPEED (FEET PER SECOND)

FIGURE 2–1 EXPERIMENTAL DESIGN OF STUDIES

2.3 APPARATUS

More complete information concerning the generation of authentic target signatures has been reported elsewhere (Levine et al., 1978). In general, individual targets (scaled at 285:1) were placed at various oblique angles with regard to sensor line-of-sight and in different background areas on a 104 by 26 ft three-dimensional terrain map (see Figure 2-2). At this scale, the detail on the

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FIGURE 2–2 THREE DIMENSIONAL TERRAIN MAP

map was sufficient to simulate bushes and scrub trees (see Figures 1-11 and 1-12). A pseudo-thermal colorimetry technique was used to create the film imagery displayed in the study. For a specific IR signature condition (active target or inactive target), portions of the vehicle were painted to model the appropriate temperature pattern. The targets and the surrounding terrain areas were photographed with either a Mamaya (Experiment I) or Hasselblad (Experiments II and III) camera, fitted with a Kodak Wratten filter. Different color coding/filter combinations produced variations in the simulated sensor imagery. When the imagery was displayed, the target signatures had luminance distributions which approximated those within actual IR imagery that served as a standard for comparison. The pseudo-thermal colorimetry technique assured a broad dynamic range with respect to gray shades when "hot" target features were displayed. Moreover, by changing the color coding of the targets, we were able to simulate normal-light-level TV signatures as well.

Extender lenses were attached to the cameras to obtain simulated 1.5° FOV imagery at the appropriate scale for each initial slant range. Further the cameras were positioned above the terrain map to provide a 10° sensor depression angle. Simulated pop-up altitudes were 868 ft, 5209 ft, and 2605 ft for Experiments I, II, and III, respectively.

Positive transparencies were made of the 108 photographs (36 per signature condition) taken in this manner (see Figures 1-10 through 1-12, examples of positive prints). The transparencies were mounted on glass slides (9 per slide) which were placed in an X-Y transport. Light was projected onto a glass diffusing surface located behind the slide to back-illuminate the transparencies. Two circular polarizers interposed between the projector and the diffusing surface provided intensity control and a uniform projection of light across each image. From the image plane, the light was collimated before passing through a servo-controlled zoom lens (20:1). The light was then collimated a second time before entering a Telemation TMC 2100 TV camera. The TV camera provided the video input for the Hitachi Model VM 905AU TV Monitor (525 lines, 3:4 aspect ratio, 9 in. diagonal) which was used in the study. Video signals were calibrated electronically for pedestal and sync levels, and the display settings were established from photometric readings (light/dark ratio of at least 20:1). Figure 2-3 presents the total system (optical assembly/camera/display) square wave response.

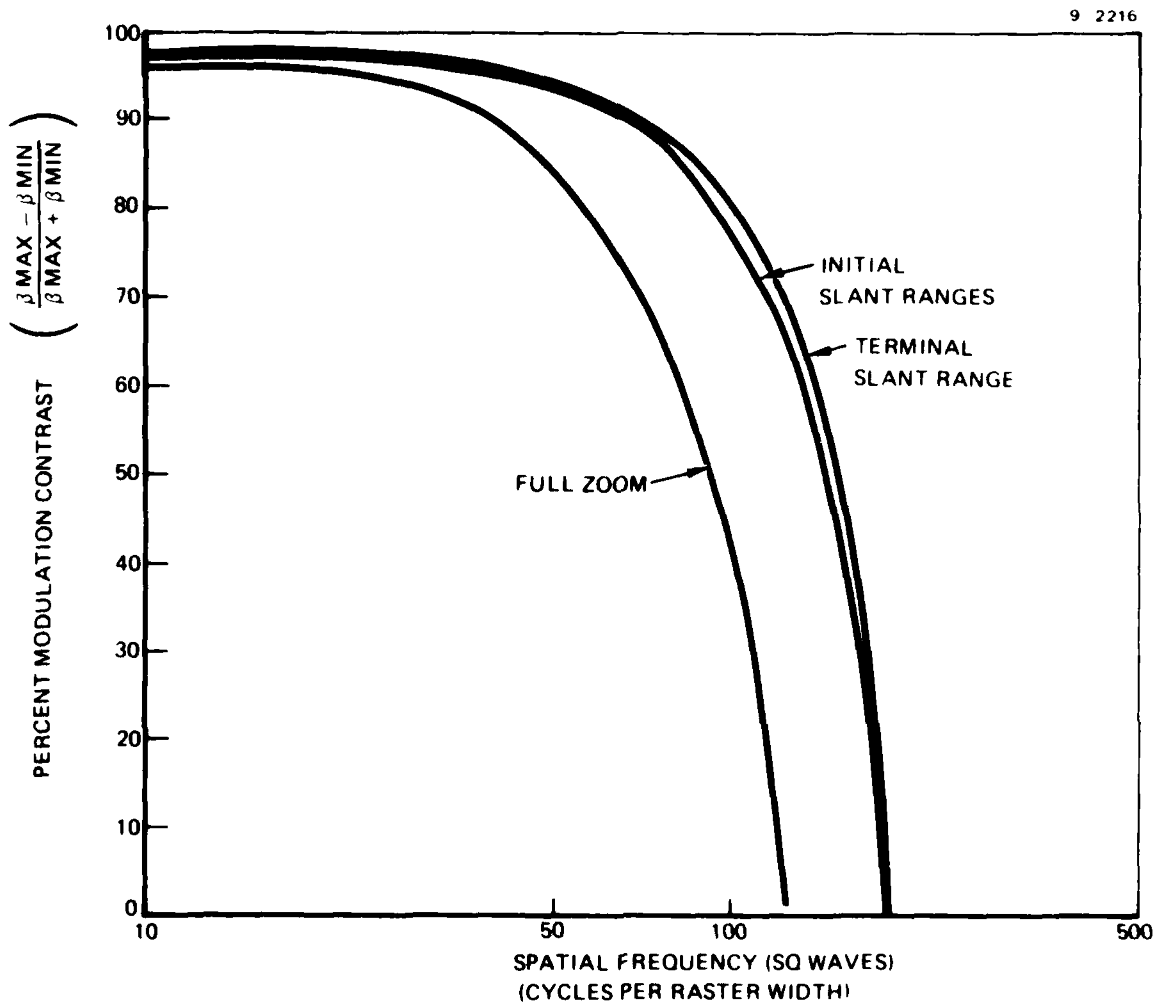


FIGURE 2–3 TOTAL SYSTEM SQUARE WAVE RESPONSES AT ZOOM SETTINGS USED IN STUDY

A PDP-8 minicomputer and associated peripherals controlled all aspects of the experiments and collected and stored the data. The image dynamics described earlier for ground-stabilized sensors were simulated by varying the functional characteristics of the zoom system. Thus, the focal length of the zoom lens determined slant range to the target at any point in time, while the rate of change in focal length determined closing velocity. Finally, movements of the X-Y transport allowed some freedom in simulating operator-initiated changes in sensor aimpoint.

The TV monitor was mounted in a console that was oriented at 120° with respect to the observer's horizontal line-of-sight (Figure 2-4). A red light-emitting diode (LED) was centered above the display, and a 2-axis force, joystick

9-2244

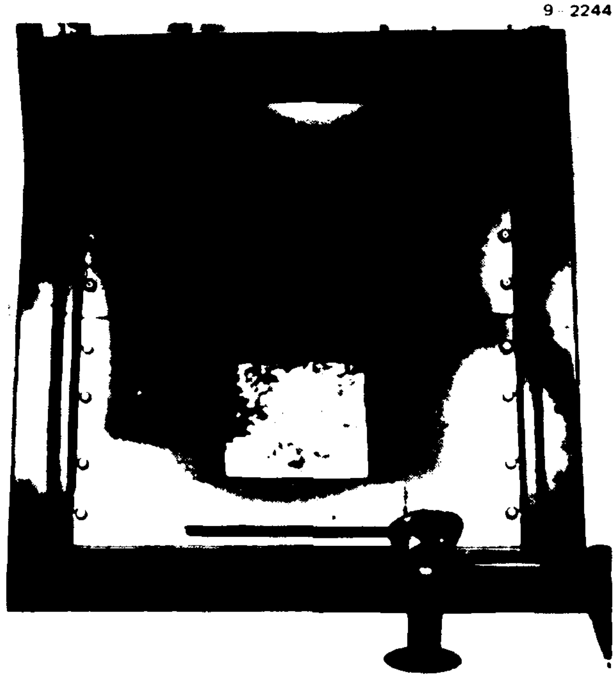


FIGURE 2-4 DISPLAY CONSOLE AND CONTROL STICK

(Measurement System, Inc., Model 435 MS-151) was positioned in front of the console. The control stick had a two-position trigger attached to the back and three response buttons mounted on the upper face. Three target identification keys were housed in a separate response box to the left of the console.

2.4 PROCEDURE

For Experiment I, two sessions per subject were required to complete visual screening, training, and experimental testing. The first session was devoted to visual acuity and Raven Progressive Matrices testing, as well as to extensive training on the target acquisition task. For Experiments II and III, two sessions also were employed, the first for training and the second for testing.

Before the training trials were initiated, the subject read a detailed description of the task requirements (see Appendix A). A verbal explanation was then given, and the response options were demonstrated. The subject was shown positive prints of each target for each signature condition, and the distinguishing features were noted. These decision aids were available at the console during all training trials.

The subjects were told that the displayed scenes were representative of those a pilot or rear seat operator would see as the aircraft approached a target area following pop-up. They were permitted to assume a comfortable viewing distance from the TV monitor (see Table 2-1). Ambient illumination, measured at the display face, was approximately 4 ftC.

Table 2-1 Mean Viewing Distance from the Display

Experiment	Mean (In)	Range (In)
I (5,000 ft)	24.2	18-29
II (30,000 ft)	19.0	17-20
III (15,000 ft)	22.7	21-25

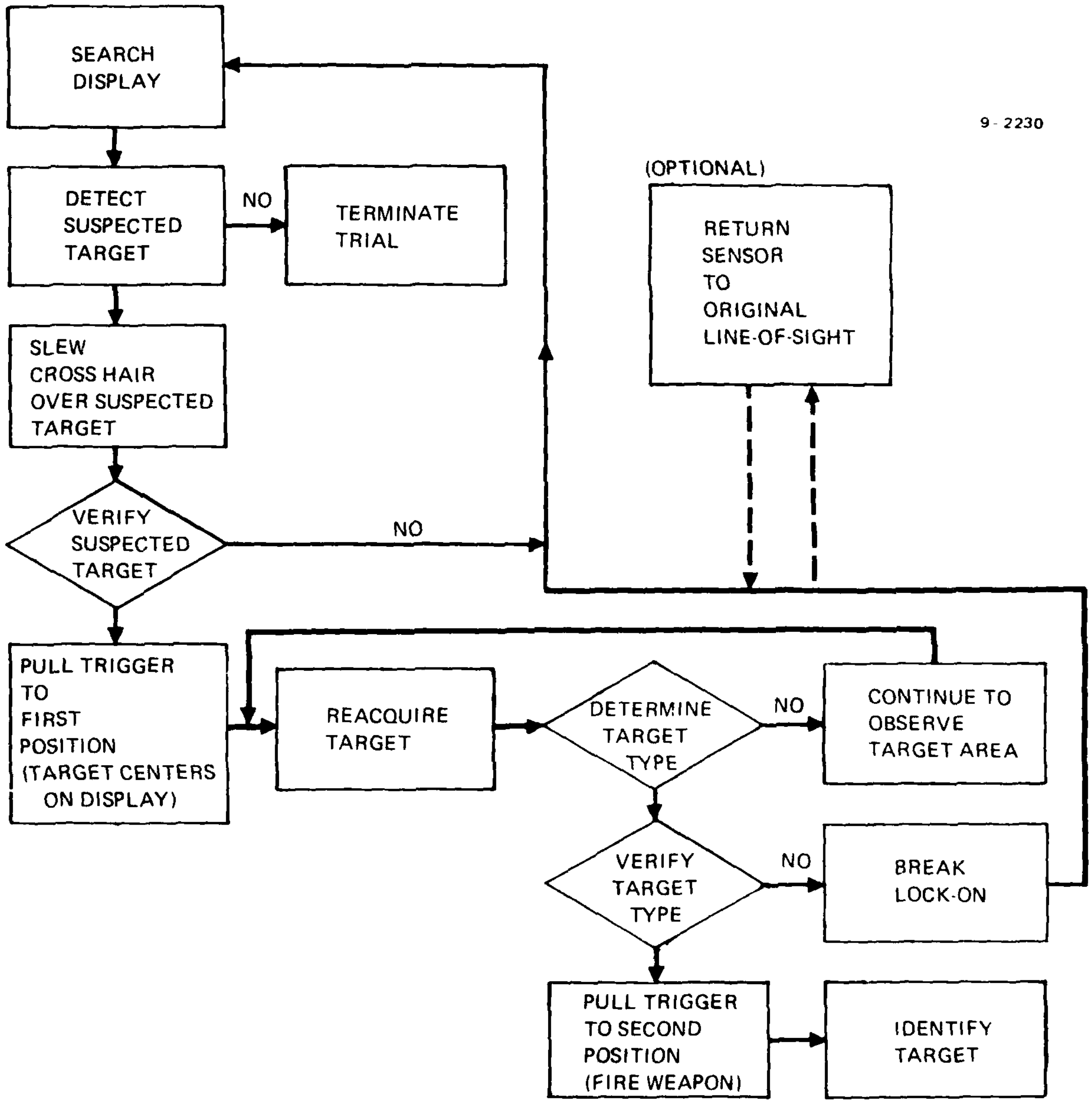
Detailed procedures were as follows. A tone was presented one second prior to the start of each trial. Intertrial intervals were approximately 10 sec, although 5 min rest periods were allocated between signature conditions. Between trials, a uniform gray field was displayed. When the trial began, the simulated sensor imagery (corresponding to the appropriate initial slant range) and an electronically generated cross hair were displayed. Again, the image dynamics were representative of a ground-stabilized sensor configuration. As soon as the subject detected a target, he was to position the cross hair over it by moving the control stick. He then was to pull the trigger to the first position in order to designate the target's location. This initiated lock-on, as coded by illumination of the LED, and it removed the cross hair from the display. It also resulted in a "reaiming of the sensor" (movement of the X-Y transport), so that the suspected target was situated directly in the center of the display[1]. When the subject was certain that he recognized the target (tank, truck, or half-track), he pulled the trigger to the second position to simulate weapon release. This second trigger pull terminated the trial, and the subject then identified the target by pressing the appropriate key on the response box. In those instances when the subject recognized the type of target as soon as he detected it, he was instructed to pull the trigger through both positions without waiting for the target to be centered.

[1] At the beginning of those trials with a target present, it would appear anywhere within the center two-thirds of the display.

If the subject determined that the placement of the cross hair and, consequently, the detection response (first trigger pull) had been incorrect, he could break lock-on by pressing the center button on the upper face of the control stick. This caused the cross hair to reappear, and the subject could slew it to a different display location before making another detection response. He also could return the sensor to its original aimpoint by pressing the button situated to the right on the upper face of the control stick. If the subject decided that no target was present within the displayed scene, he would press the button located to the left on the upper face of the control stick and terminate the trial. Finally, the trial would terminate automatically should a slant range of 1000 ft (Experiment I) or 5000 ft (Experiments II and III) be reached before a recognition or "no target" response occurred. A flow diagram of the response options is shown in Figure 2-5.

Both speed and accuracy were stressed in the instructions. For each experiment, the subjects received 100 training trials before they were tested for asymptotic performance. That is, prior to each experimental session, the subjects had to meet the following performance criterion with respect to training:

> correctly detect (position cross hair) and identify targets or correctly determine that no target was present on 18 consecutive trials.



FLOW 2–5 FLOW DIAGRAM OF THE TARGET ACQUISITION TASK

3.0 RESULTS AND DISCUSSION: 5,000 FT INITIAL SLANT RANGE

The results of the study which assumed a 5,000 ft initial slant range have been reported previously (Levine, Beideman, and Gomer, 1980). Therefore, only a brief review of those findings will be presented.

3.1 ACCURACY

Chi square tests were performed on scores related to the accuracy of detection and recognition. None of the independent variables (target signature, target type, background scene complexity, or closure rate) influenced the accuracy of performance.

3.2 RESPONSE TIME (LATENCY) TO DETECTION AND RECOGNITION

For this study, a reciprocal (1/X) transformation was applied to all response time data to eliminate heterogeneity of variance (Edwards, 1965). Analyses of variance were performed and the appropriate Newman-Keuls tests were computed for these data. As expected, the main effect of the subject variable was significant; however, these data will not be discussed since the study was not concerned with individual differences.

The major findings for both the response time to detection and the response time to recognition were:

(1) Response times were shorter for active target than for inactive target FLIR signatures, which in turn were shorter than for TV target signatures ($ps < .05$).

(2) Response times were greater for background scenes of medium complexity than for background scenes of either high or low complexity ($ps < .05$), however, response times did not differ significantly for the latter two levels of background scene complexity.

3.3 RANGE TO TARGET AT DETECTION AND RECOGNITION

A reciprocal (1/X) transformation was applied to these data as well. Further, analyses of variance were performed and Newman-Keuls tests were computed. The primary results were:

(1) The range to target at recognition was greater for active target than for inactive target FLIR signatures, which in turn was greater than for TV target signatures (ps $<.05$).

(2) For both detection and recognition, the association between aircraft speed and range to target was exceptionally robust (eta^2 = 70 and 60%, respectively). Due to the large size of the target on the display at the beginning of a trial, subjects generally responded very rapidly, and detection and recognition occurred at virtually the same instant. With our well-trained observers, response times remained quite stable across different closure rates. (Statistical significance in the case of closure rate and its effect on response time was not associated with a large eta^2 value.) Therefore, the speed of the aircraft was the primary determinant of range. As you would expect within the context of our simulation, the slower the speed of the aircraft the greater the range to the target when acquisition occurred. For both detection and recognition, the range to target was greater at an aircraft speed of 250 ft/sec than at a speed of 500 ft/sec, which in turn was greater than at a speed of 1000 ft/sec (ps $<.05$).

3.4 CONCLUSIONS

In order to examine dynamic visual perception within the context of an operationally relevent target acquisition task, we developed a simulation procedure that allowed us to vary parameters which directly impact the effectiveness of an imaging sensor system. The operational characteristics of certain attack aircraft and imaging missiles led us first to examine an initial slant range of 5000 ft (although extended stand-off ranges were evaluated in experiments II and III). As a result, the displayed images of targets in the first experiment exceeded size thresholds for recognition from the beginning of a trial. Thus, little visual search of the display was required. Morever, detection and recognition responses were frequently made almost simultaneously, except for a slight time delay associated with depression of the two-position trigger. Because of the essentially reaction-time nature of the task, background scene complexity and target type had statistically significant effects on performance that lacked robustness, i.e., accounted for negligible proportions of the total variance.

However, even within the context of relatively close-in start ranges, IR targets were detected and recognized more rapidly and at greater distances than comparable TV targets.

4.0 RESULTS AND DISCUSSION: 15,000 FT INITIAL SLANT RANGE

Consideration of various aircraft, missile, and ordnance characteristics led us to examine a 15,000 ft initial slant range to target following pop-up. With this slant range and a simulated 1.5° FOV, the duration of visual search depended upon the level of background scene complexity. However, the displayed targets were suprathreshold for both detection and recognition at the beginning of a trail. Therefore, the reaction-time nature of the task was similar to that of the 5,000 ft. initial slant range study.

A Statistical Analysis System (SAS) computer program which assumed a linear model solution was used for the analyses of variance and for the eta^2 comparison analyses. Newman-Keuls tests were performed separately to assess simple effects. To limit our discussion to the more important findings, the reporting of results has been restricted primarily to overall main effects and to interactions involving target signature and background scene complexity.

4.1 ACCURACY

Chi square tests were performed on scores derived from (a) the number of trials in which the observers correctly positioned the cross hair when designating target location (detection); (b) the number of trials in which the target was identified correctly following weapon release (recognition); and (c) the number of trials in which the observers correctly indicated that no target was present within the displayed scene. None of the independent variables (target signature, target type, background scene complexity or closure rate) influenced the accuracy of performance as defined above. These findings probably reflect both the nature of the task and the level of training of the subjects.

4.2 RESPONSE TIME (LATENCY) TO DETECTION AND RECOGNITION

Response time data did not require transformation. Summaries of the analyses of variance performed on response times to detection and recognition are presented in Tables 4-1 and 4-2, respectively. The main effect of the subject variable was highly significant and extremely robust (eta^2) for these analyses as well as for all other analyses. However, since we are not concerned with individual differences in this report, these data will not be discussed.

TABLE 4-1 Analysis of Variance Summary Table for the Response Time to Target Detection: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	162.5	37.6	.01	.078
SCENCOMP	2	149.7	34.7	.01	.071
SPEED	2	15.5	3.6	.03	.007
TGTTYP	2	16.2	3.8	.03	.008
SUBJECT	5	311.1	28.8	.01	.149
SIG X SCENCOMP	4	104.2	12.1	.01	.050
SIG X SPEED	4	97.8	11.3	.01	.046
SIG X TGTTYP	4	81.7	9.5	.01	.038
SCENCOMP X SPEED	4	16.7	1.9	.11	.008
SCENCOMP X TGTTYP	4	34.5	4.0	.01	.016
SPEED X TGTTYP	4	16.8	1.9	.11	.008
SIG X SCENCOMP X SPEED	8	35.1	2.0	.05	.017
SIG X SCENCOMP X TGTTYP	8	78.8	4.6	.01	.037
SIG X SPEED X TGTTYP	8	74.8	4.3	.01	.035
SCENCOMP X SPEED X TGTTYP	8	68.0	3.9	.01	.032
SIG X SCENCOMP X SPEED X TGTTYP	11	128.5	4.6	.01	.061
ERROR	323	697.6			
CORRECTED TOTAL	405	2089.5			

TOTAL VARIANCE ACCOUNTED FOR (R^2) = .666

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 4-2 Analysis of Variance Summary Table for the Response Time to Target Recognition: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	162.1	11.1	.01	.027
SCENCOMP	2	12.3	0.8	.44	.002
SPEED	2	77.2	5.3	.01	.013
TGTTYP	2	32.8	2.2	.11	.005
SUBJECT	5	702.4	19.2	.01	.119
SIG X SCENCOMP	4	134.2	4.6	.01	.023
SIG X SPEED	4	276.8	9.4	.01	.047
SIG X TGTTYP	4	207.4	7.1	.01	.035
SCENCOMP X SPEED	4	89.1	3.0	.02	.015
SCENCOMP X TGTTYP	4	114.2	3.9	.01	.019
SPEED X TGTTYP	4	152.0	5.2	.01	.026
SIG X SCENCOMP X SPEED	8	154.4	2.6	.01	.026
SIG X SCENCOMP X TGTTYP	8	99.7	1.7	.10	.017
SIG X SPEED X TGTTYP	8	301.7	5.1	.01	.051
SCENCOMP X SPEED X TGTTYP	8	169.8	2.9	.01	.029
SIG X SCENCOMP X SPEED X TGTTYP	11	837.4	8.8	.01	.142
ERROR	323	2369.5			
CORRECTED TOTAL	405	5893.1			

TOTAL VARIANCE ACCOUNTED FOR (R^2) = .598

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

4.2.1 Detection - Figures 4-1 through 4-4 show the significant main effects and the interaction of signature by background scene complexity. Individual comparisons can be found in Appendix B, Tables B-1 through B-5. The primary findings were:

(1) Response times to the active target FLIR signatures were faster than those to the inactive target FLIR signatures which, in turn, were more rapid than those to the TV target signatures ($ps < .05$).

(2) There were no significant response time differences under the medium and high background scene complexity conditions, however, response times under the low background scene complexity condition were more rapid than those for the former conditions ($ps < .05$).

(3) For closure rate, response times to detection were most rapid under the 1000 ft/sec condition ($ps < .05$). Response times associated with the 500 and 250 ft/sec conditions did not differ from one another.

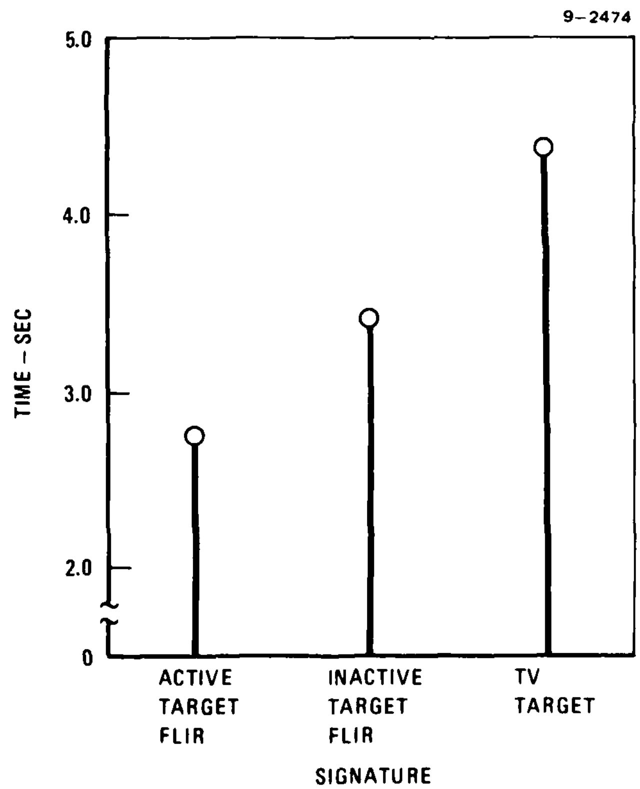


FIGURE 4–1 RESPONSE TIME TO TARGET DETECTION – SIGNATURE (15,000 FT INITIAL SLANT RANGE)

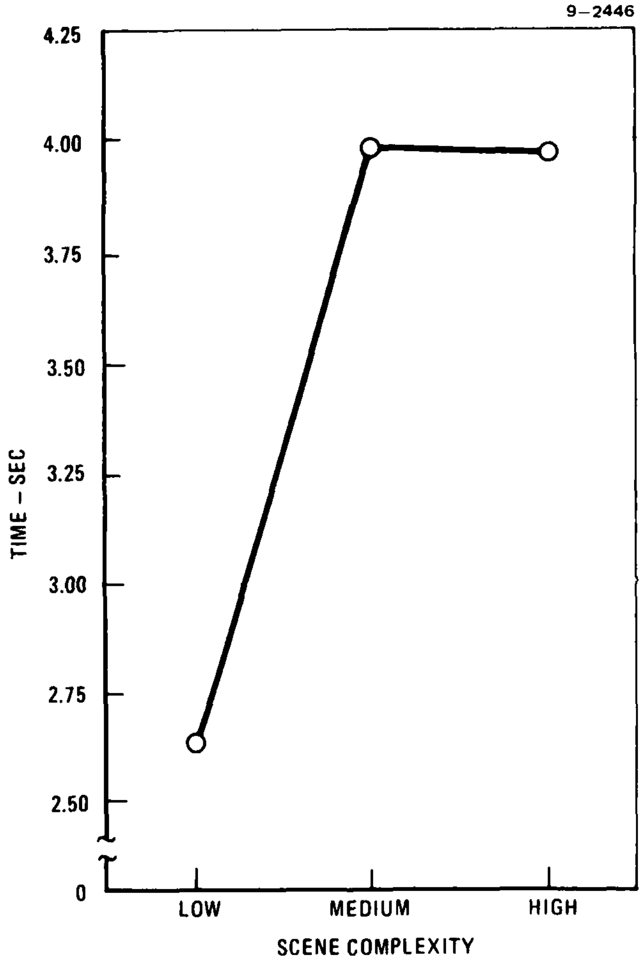


FIGURE 4–2 RESPONSE TIME TO TARGET DETECTION – SCENE COMPLEXITY (15,000 FT INITIAL SLANT RANGE)

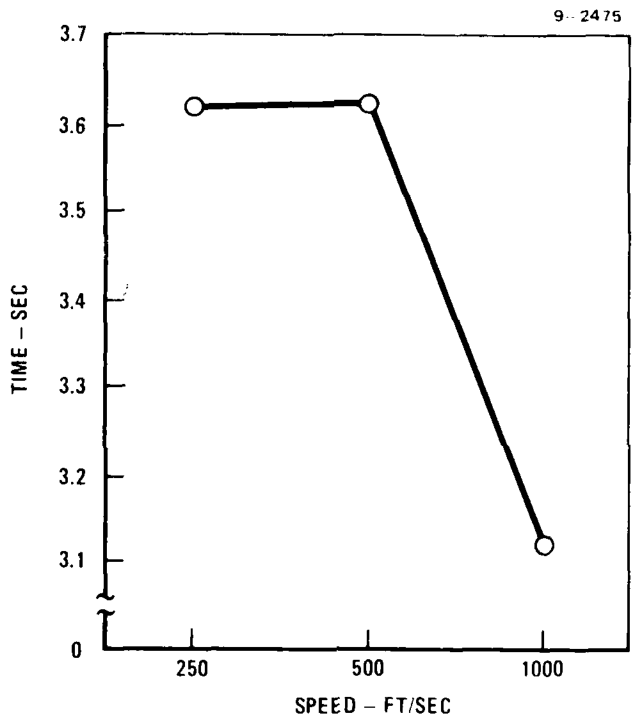


FIGURE 4–3 RESPONSE TIME TO TARGET DETECTION – SPEED (15,000 FT INITIAL SLANT RANGE)

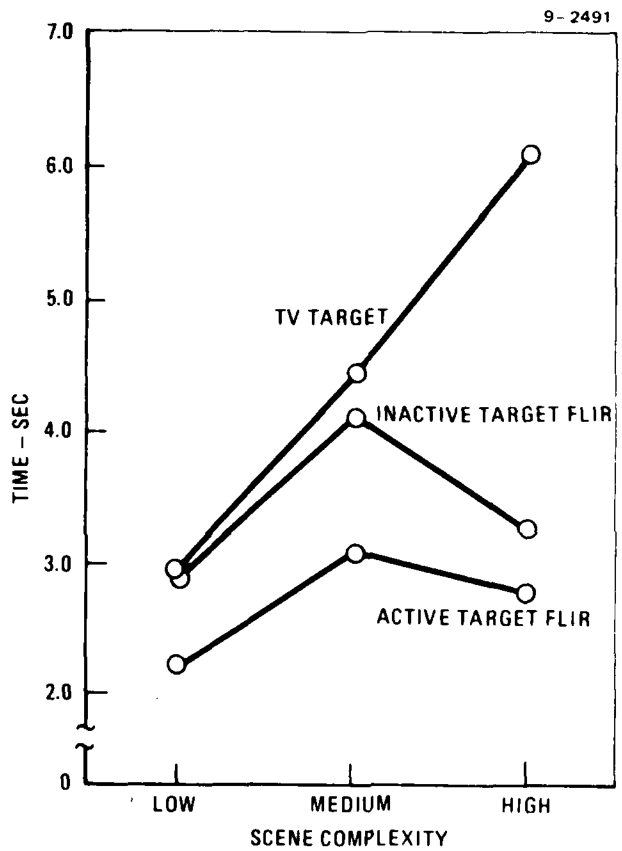


FIGURE 4–4 RESPONSE TIME TO TARGET DETECTION – SIGNATURE X SCENE COMPLEXITY INTERACTION (15,000 FT INITIAL SLANT RANGE)

(4) Response times to the truck targets were more rapid than those to the tank targets (ps < .05). Response times to the tank and half-track targets did not differ. (Response time differences due to target type were consistently negligible. Therefore, no figures are included in the remainder of Section 4.0.)

(5) For the signature by background scene complexity interaction, response times were slower for the TV target signatures than for either class of IR target signature under the high background scene complexity condition (ps < .05). Under the medium background scene complexity condition, response times were slower for the TV target signatures than for the active target FLIR signatures (ps < .05). Under low background scene complexity condition, there were no differences in performance attributable to signature.

4.2.2 Recognition - The overall main effects and the signature by background scene complexity interaction are depicted in Figures 4-5 through 4-7. Specific individual comparisons are presented in Tables B-6 through B-10 in Appendix B. The findings are listed below.

(1) The most rapid response times were associated with the active target FLIR signatures, while the least rapid response times were associated with TV target signatures (ps < .05). Response times to the inactive targets FLIR signatures were at an intermediate level.

(2) Response times for the 1000 ft/sec closure rate were faster than those for the 250 and 500 ft/sec closure rates (ps < .05). The latter rates did not differ significantly.

(3) Under the high background scene complexity condition, response times were slower for the TV target signatures than for either class of IR target signature (ps < .05). Signature did not affect performance under either the low or medium background scene complexity conditions.

4.3 RANGE AT TARGET DETECTION AND RECOGNITION

The range data did not require transformation. Summaries for the analyses of variance are presented in Tables 4-3 and 4-4, respectively.

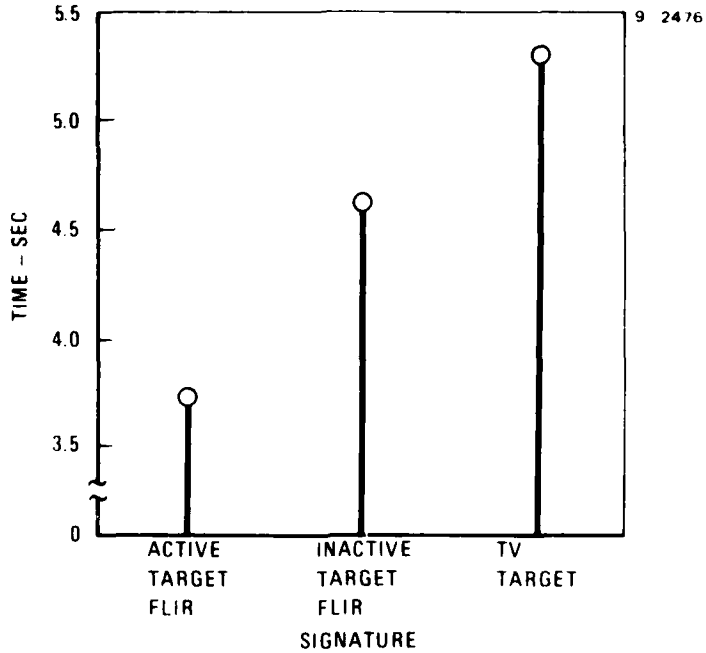


FIGURE 4–5 RESPONSE TIME TO TARGET RECOGNITION – SIGNATURE (15,000 FT INITIAL SLANT RANGE)

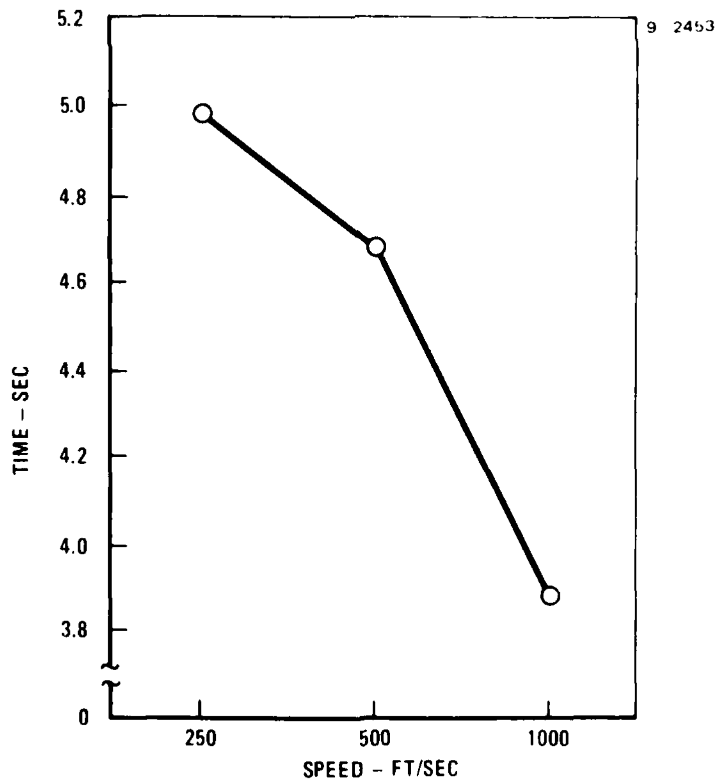


FIGURE 4–6 RESPONSE TIME TO TARGET RECOGNITION – SPEED (15,000 FT INITIAL SLANT RANGE)

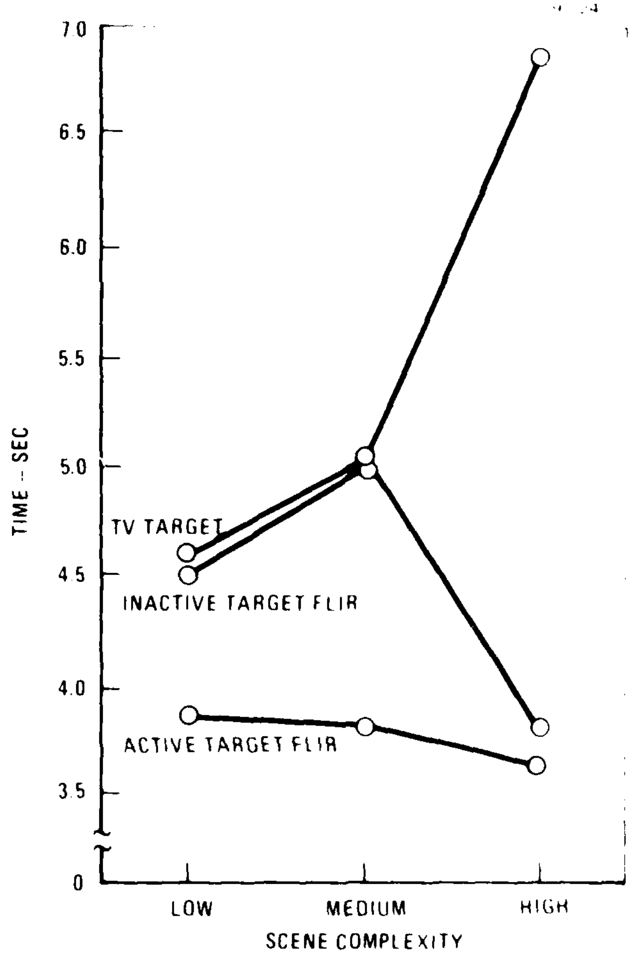


FIGURE 4–7 RESPONSE TIME TO TARGET RECOGNITION – SIGNATURE X SCENE COMPLEXITY INTERACTION (15,000 FT INITIAL SLANT RANGE)

4.3.1 Detection - Figures 4-8 through 4-11 illustrate the overall main effects and the signature by background scene complexity interaction. Specific comparisons are presented in Appendix B, Tables B-11 through B-15. A summary of the results follows.

(1) The longest stand-off ranges were associated with the active target FLIR signatures while the shortest stand-off ranges were associated with the TV target signatures ($ps < .05$). Intermediate stand-off ranges were found for the inactive target FLIR signatures.

TABLE 4-3 Analysis of Variance Summary Table for the Range at Target Detection: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P	eta^2
SIG	2	31881216.2	22.8	.01	.033
SCENCOMP	2	27758039.5	19.9	.01	.029
SPEED	2	358563209.7	256.4	.01	.371
TGTTYP	2	8800547.7	6.3	.01	.009
SUBJECT	5	81395225.4	23.3	.01	.084
SIG X SCENCOMP	4	26082988.5	9.3	.01	.027
SIG X SPEED	4	25889978.5	9.3	.01	.027
SIG X TGTTYP	4	24756350.6	8.9	.01	.026
SCENCOMP X SPEED	4	3230754.6	1.2	.34	.003
SCENCOMP X TGTTYP	4	7321203.8	2.6	.04	.008
SPEED X TGTTYP	4	14825925.6	5.3	.01	.015
SIG X SCENCOMP X SPEED	8	22121345.7	4.0	.01	.023
SIG X SCENCOMP X TGTTYP	8	18265811.6	3.3	.01	.019
SIG X SPEED X TGTTYP	8	28670055.6	5.2	.01	.030
SCENCOMP X SPEED X TGTTYP	8	20464819.1	3.7	.01	.021
SIG X SCENCOMP X SPEED X TGTTYP	11	39669346.9	4.4	.01	.041
ERROR	323	225893118.5			
CORRECTED TOTAL	405	965589937.3			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.766

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 4-4 Analysis of Variance Summary Table for the Range at Target Recognition: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	4016197.6	12.7	.01	.022
SCENCOMP	2	460312.8	0.2	.87	.000
SPEED	2	505688486.6	160.0	.01	.279
TGTTYP	2	17579412.3	5.6	.01	.010
SUBJECT	5	154443033.4	19.6	.01	.085
SIG X SCENCOMP	4	53312756.0	8.4	.01	.029
SIG X SPEED	4	59729721.9	9.5	.01	.033
SIG X TGTTYP	4	59125817.9	9.4	.01	.033
SCENCOMP X SPEED	4	13497830.8	2.1	.08	.007
SCENCOMP X TGTTYP	4	14005468.2	2.2	.07	.008
SPEED X TGTTYP	4	38169246.9	6.0	.01	.021
SIG X SCENCOMP X SPEED	8	81546012.7	6.5	.01	.045
SIG X SCENCOMP X TGTTYP	8	14010454.0	1.1	.36	.008
SIG X SPEED X TGTTYP	8	77235134.4	6.1	.01	.043
SCENCOMP X SPEED X TGTTYP	8	39016631.3	3.1	.01	.022
SIG X SCENCOMP X SPEED X TGTTYP	11	136295053.0	6.6	.01	.075
ERROR	323	510437050.5			
CORRECTED TOTAL	405	1814714120.4			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.719

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

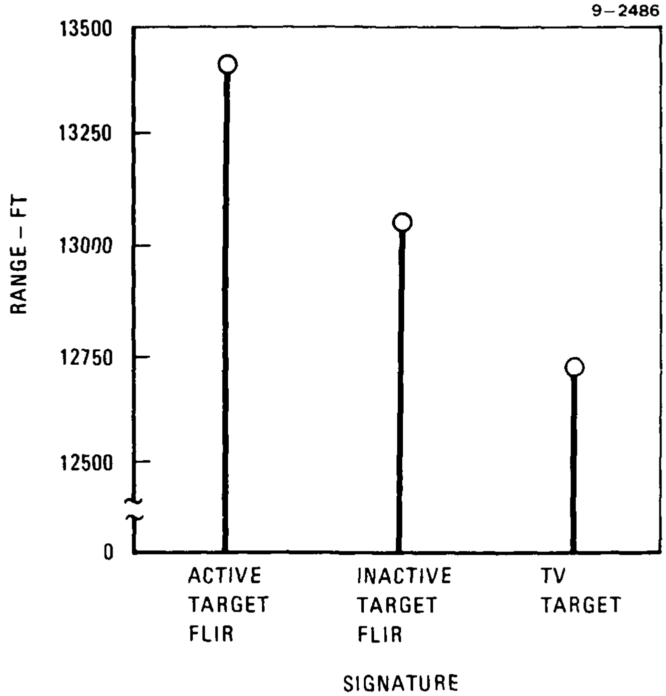


FIGURE 4–8 RANGE AT TARGET DETECTION – SIGNATURE (15,000 FT INITIAL SLANT RANGE)

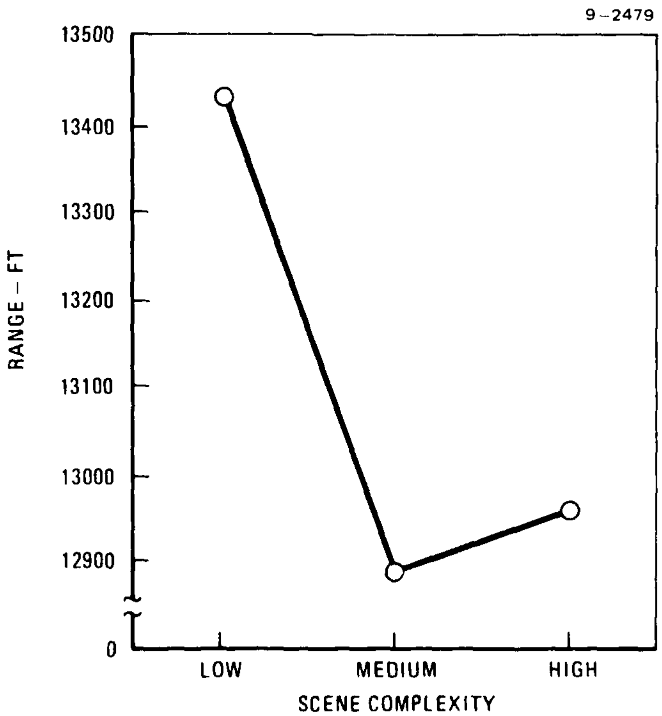


FIGURE 4–9 RANGE AT TARGET DETECTION – SCENE COMPLEXITY (15,000 FT INITIAL SLANT RANGE)

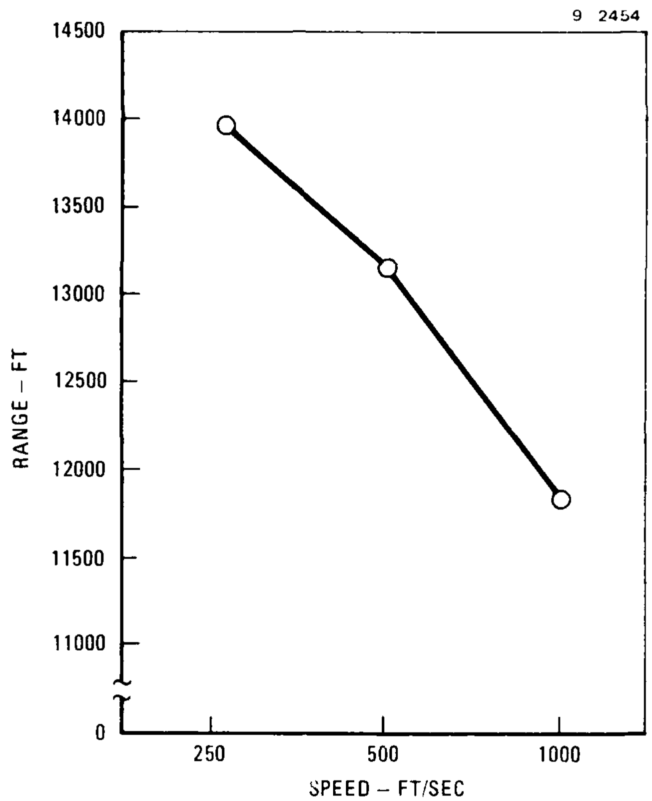


FIGURE 4–10 RANGE AT TARGET DETECTION – SPEED (15,000 FT INITIAL SLANT RANGE)

(2) Targets embedded in low complexity background scenes were detected at longer stand-off ranges than those embedded in medium or high complexity background scenes ($ps < .05$). For the latter two conditions, stand-off ranges did not differ.

(3) Stand-off range was ordered, from longest to shortest, for the 250, 500, and 1000 ft/sec closure rates, respectively ($ps < .05$).

(4) Although the effects of target type on stand-off range at detection were significant, the range differences were small. Stand-off ranges were longer for the half-track and truck targets than for to the tank targets ($ps < .05$).

(5) Under the medium background scene complexity condition, stand-off ranges for the active target FLIR signatures were longer than those for the inactive target FLIR or TV target signatures ($ps < .05$). Under the high background scene complexity condition, however, both the active and inactive target FLIR signatures were associated with greater stand-off

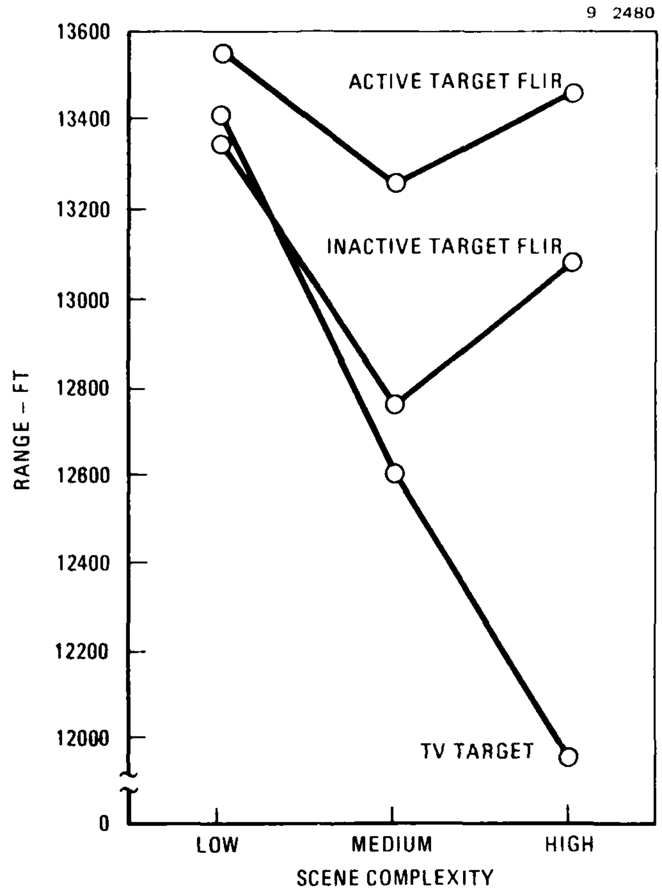


FIGURE 4–11 RANGE AT TARGET DETECTION – SIGNATURE X SCENE COMPLEXITY INTERACTION (15,000 FT INITIAL SLANT RANGE)

ranges than were the TV target signatures ($ps < .05$). The FLIR target signatures did not differ significantly. Signature did not influence range to target detection under the low background scene complexity condition.

4.3.2 <u>Recognition</u> - Figures 4-12, 13, and 14 depict the range data for target recognition. To further interpret the data, refer to the Appendix B, Tables B-16 through B-20. The primary findings were:

(1) The stand-off ranges for the inactive target FLIR and TV target signatures were not significantly different. However, both classes of signature were associated with shorter ranges than were active target FLIR signatures ($ps < .05$).

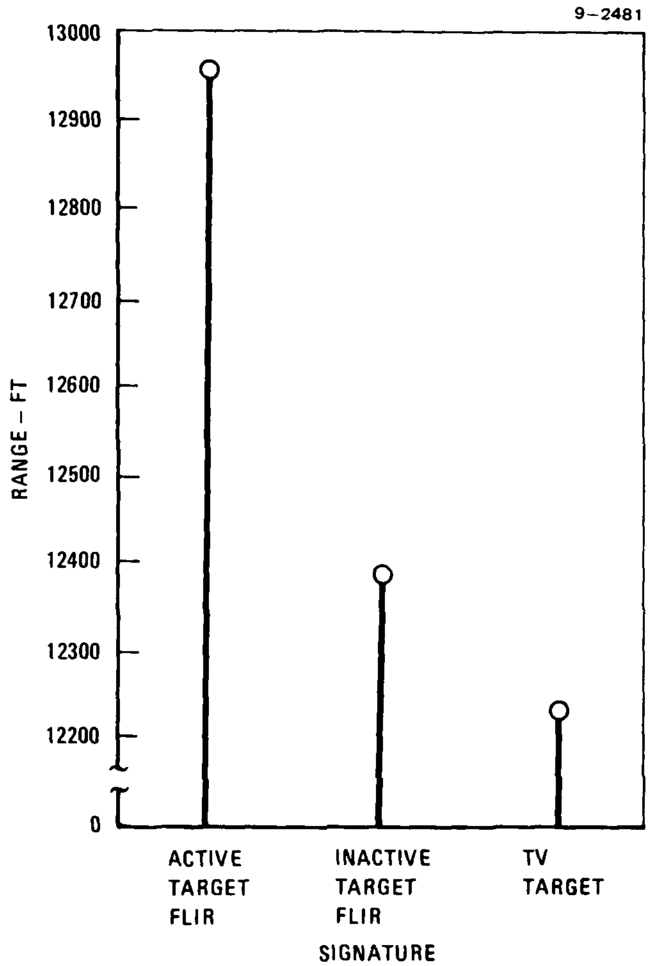


FIGURE 4–12 RANGE AT TARGET RECOGNITION – SIGNATURE (15,000 FT INITIAL SLANT RANGE)

(2) Stand-off ranges for the three closure rates differed significantly. The 250 ft/sec closure rate resulted in the greatest stand-off range and the 1000 ft/sec closure rate resulted in the shortest ($ps < .05$).

(3) While statistically significant, the effects of target type were small. Stand-off ranges associated with truck targets were greater than those for the other targets ($ps < .05$).

(4) Under the high background scene complexity condition, stand-off ranges for both FLIR target signatures, while not differing from each other, were longer than those for the TV target signatures ($ps < .05$). Under the low and medium background scene complexity conditions, there were no significant stand-off range differences for the three types of target signatures.

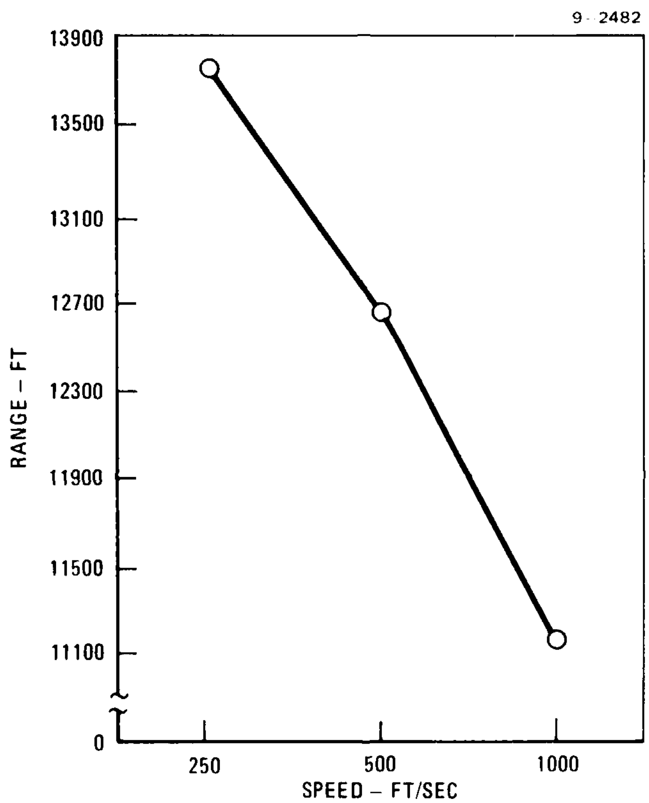


FIGURE 4–13 RANGE AT TARGET RECOGNITION – SPEED
(15,000 FT INITIAL SLANT RANGE)

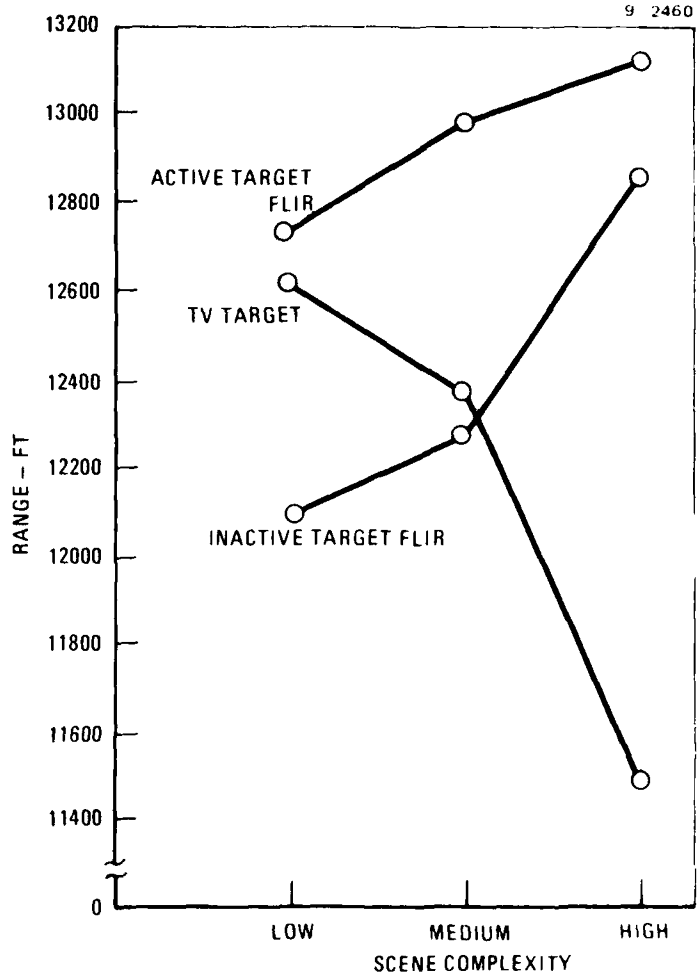


FIGURE 4–14 RANGE AT TARGET RECOGNITION – SIGNATURE X SCENE COMPLEXITY INTERACTION (15,000 FT INITIAL SLANT RANGE)

4.4 TARGET SIZE AT DETECTION AND RECOGNITION

The analyses of variance for target width on the display at detection and recognition are presented in Tables 4-5 and 4-6, respectively. In our simulation the range and target size data were highly correlated. Therefore, discussion of target width data will be limited. However, for the readers' convenience, the means and individual comparisons are presented in Appendix B, Tables B-21 through B-30.

TABLE 4-5 Analysis of Variance Summary Table for the Target Width at Target Detection: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	.00537	4.7	.01	.006
SCENCOMP	2	.11106	97.0	.01	.118
SPEED	2	.11650	101.7	.01	.124
TGTTYP	2	.14086	123.0	.01	.150
SUBJECT	5	.02652	9.3	.01	.028
SIG X SCENCOMP	4	.01768	7.7	.01	.019
SIG X SPEED	4	.02554	11.2	.01	.027
SIG X TGTTYP	4	.05694	24.9	.01	.061
SCENCOMP X SPEED	4	.01618	7.1	.01	.017
SCENCOMP X TGTTYP	4	.01055	4.6	.01	.011
SPEED X TGTTYP	4	.02935	12.8	.01	.031
SIG X SCENCOMP X SPEED	8	.04138	9.0	.01	.044
SIG X SCENCOMP X TGTTYP	8	.02889	6.3	.01	.031
SIG X SPEED X TGTTYP	8	.05010	10.9	.01	.053
SCENCOMP X SPEED X TGTTYP	8	.02240	4.9	.01	.024
SIG X SCENCOMP X SPEED X TGTTYP	11	.05532	7.4	.01	.059
ERROR	323	.18495			
CORRECTED TOTAL	405	93958			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.803

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 4-6 Analysis of Variance Summary Table for the Target Width at Target Recognition: 15,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	p	eta^2
SIG	2	.00820	2.9	.06	.006
SCENCOMP	2	.04124	14.7	.01	.029
SPEED	2	.21230	75.5	.01	.149
TGTTYP	2	.12738	45.3	.01	.090
SUBJECT	5	.06557	9.3	.01	.046
SIG X SCENCOMP	4	.03400	6.0	.01	.024
SIG X SPEED	4	.04273	7.6	.01	.030
SIG X TGTTYP	4	.10927	19.4	.01	.077
SCENCOMP X SPEED	4	.00694	1.2	.30	00[illegible]
SCENCOMP X TGTTYP	4	.01178	2.1	.09	008
SPEED X TGTTYP	4	.03981	7.1	.01	028
SIG X SCENCOMP X SPEED	8	.06728	6.0	.01	.047
SIG X SCENCOMP X TGTTYP	8	.02167	1.9	06	015
SIG X SPEED X TGTTYP	8	.06905	6.1	.01	049
SCENCOMP X SPEED X TGTTYP	8	.01705	1.5	.16	.012
SIG X SCENCOMP X SPEED X TGTTYP	11	.09329	5.1	.01	.066
ERROR	323	.45426			
CORRECTED TOTAL	405	1.42164			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.680

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

5.0 RESULTS AND DISCUSSION: 30,000 FT INITIAL SLANT RANGE

These data were analyzed in the same manner as the data from the 5,000 and 15,000 ft studies. In addition, the SAS multiple stepwise regression program (MAXR) was used for the development of preliminary descriptive target acquisition models.

5.1 ACCURACY

Employing the same test as in the previous studies, we found that none of the variables differentially influenced the accuracy of performance.

5.2 RESPONSE TIME (LATENCY) TO DETECTION AND RECOGNITION

The latency data did not require transformation. Tables 5-1 and 5-2 summarize the analyses of variance for the response time to detection and recognition, respectively. Again, the subject main effect which was highly robust (eta^2), will not be discussed.

5.2.1 Detection - Overall main effects and the signature by background scene complexity interaction may be interpreted by referring to Figures 5-1 through 5-4 and to the corresponding individual comparisons reported in Tables B-31 through B-35 in Appendix B. The primary findings were:

(1) Response times associated with active target FLIR signatures were more rapid than those associated with inactive target FLIR or TV target signatures ($ps < .05$), however, response times did not differ significantly for the latter two signature classes.

(2) Response times were most rapid when targets were embedded in low complexity background scenes. Although the effects were not large, response times to targets embedded in scenes with medium background complexity were faster than to targets embedded in scenes with high background complexity. (All $ps < .05$)

(3) Response times were more rapid for closure rates of 1000 ft/sec than for closure rates of 500 ft/sec which, in turn, were more rapid than for closure rates of 250 ft/sec ($ps < .05$).

TABLE 5-1 Analysis of Variance Summary Table for the Response Time to Target Detection: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	1328.4	22.4	.01	.041
SCENCOMP	2	6153.8	103.7	.01	.191
SPEED	2	581.6	9.8	.01	.018
TGTTYP	2	110.5	1.9	.16	.003
SUBJECT	5	2197.0	14.8	.01	.068
SIG X SCENCOMP	4	1092.0	9.2	.01	.034
SIG X SPEED	4	1398.3	11.8	.01	.043
SIG X TGTTYP	4	1328.0	11.2	.01	.041
SCENCOMP X SPEED	4	363.7	3.1	.02	.011
SCENCOMP X TGTTYP	4	707.7	6.0	.01	.022
SPEED X TGTTYP	4	673.7	5.7	.01	.021
SIG X SCENCOMP X SPEED	8	3804.7	16.0	.01	.118
SIG X SCENCOMP X TGTTYP	8	1772.0	7.5	.01	.055
SIG X SPEED X TGTTYP	8	890.7	3.8	.01	.028
SCENCOMP X SPEED X TGTTYP	8	844.1	3.6	.01	.026
SIG X SCENCOMP X SPEED X TGTTYP	11	1899.2	5.8	.01	.059
ERROR	239	7093.0			
CORRECTED TOTAL	319	32228.6			

TOTAL VARIANCE ACCOUNTED FOR $(R^2)=.779$

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 5-2 Analysis of Variance Summary Table for the Response Time to Target Recognition: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	4791.8	30.4	.01	.069
SCENCOMP	2	1420.4	9.0	.01	.020
SPEED	2	9321.9	59.1	.01	.134
TGTTYP	2	550.6	3.5	.03	.008
SUBJECT	5	12438.3	31.5	.01	.179
SIG X SCENCOMP	4	891.0	2.8	.03	.013
SIG X SPEED	4	2897.5	9.2	.01	.042
SIG X TGTTYP	4	1482.1	4.7	.01	.021
SCENCOMP X SPEED	4	1061.2	3.4	.01	.015
SCENCOMP X TGTTYP	4	2196.9	7.0	.01	.032
SPEED X TGTTYP	4	622.0	2.0	.10	.009
SIG X SCENCOMP X SPEED	8	3764.8	6.0	.01	.054
SIG X SCENCOMP X TGTTYP	8	2630.4	4.2	.01	.038
SIG X SPEED X TGTTYP	8	1360.9	2.2	.03	.020
SCENCOMP X SPEED X TGTTYP	8	892 6	1.4	.19	.013
SIG X SCENCOMP X SPEED X TGTTYP	11	4358.3	5.0	.01	.063
ERROR	239	18856.0			
CORRECTED TOTAL	319	69536.7			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.728

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

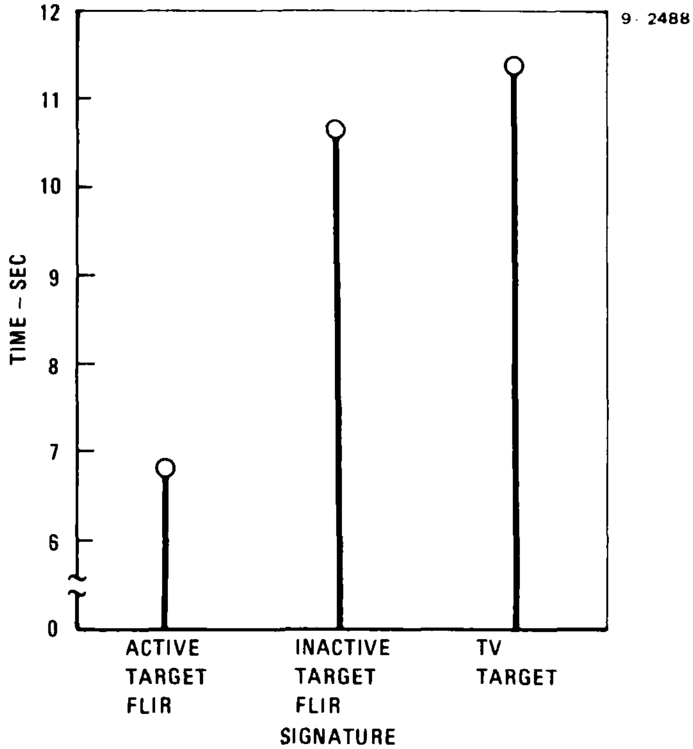


FIGURE 5–1 RESPONSE TIME TO TARGET DETECTION – SIGNATURE (30,000 FT INITIAL SLANT RANGE)

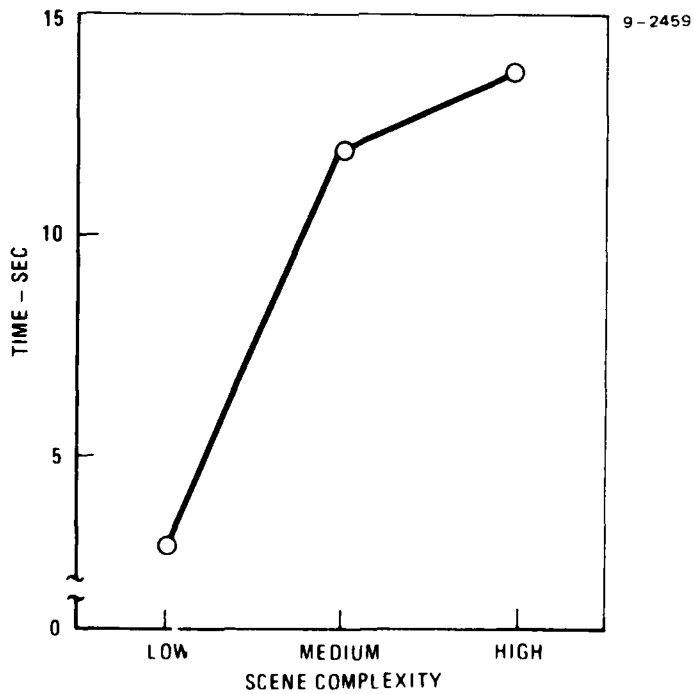


FIGURE 5–2 RESPONSE TIME TO TARGET DETECTION – SCENE COMPLEXITY (30,000 FT INITIAL SLANT RANGE)

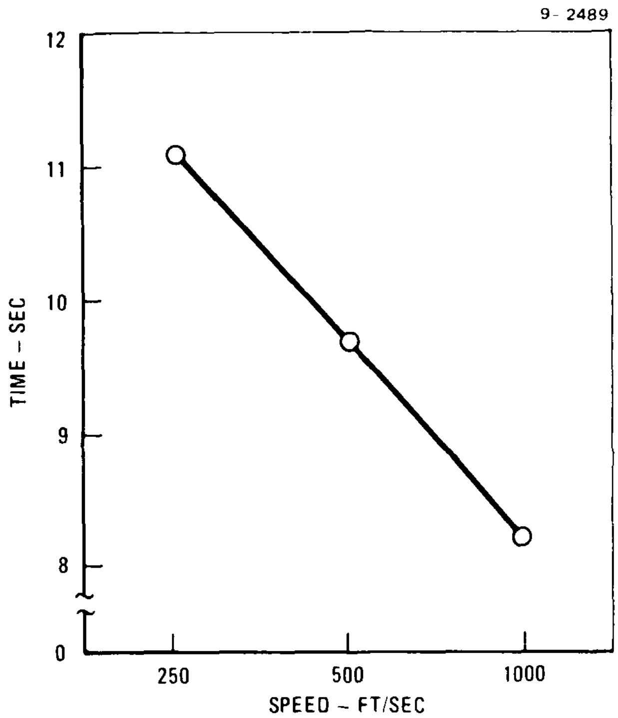


FIGURE 5–3 RESPONSE TIME TO TARGET DETECTION – SPEED
(30,000 FT INITIAL SLANT RANGE)

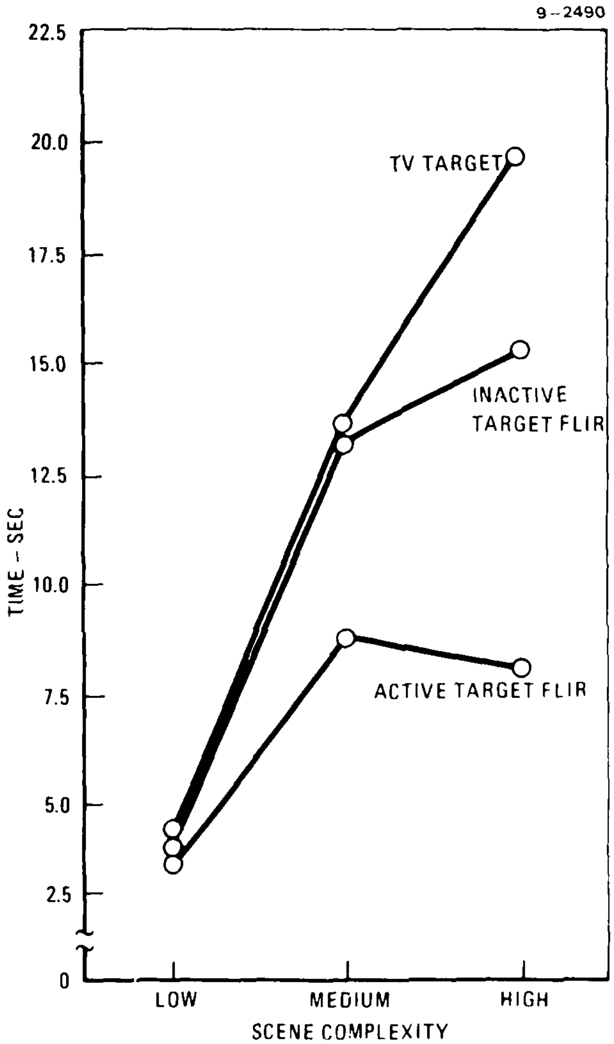


FIGURE 5–4 RESPONSE TIME TO TARGET DETECTION – SIGNATURE X SCENE COMPLEXITY INTERACTION (30,000 FT INITIAL SLANT RANGE)

(4) For the interaction of target signature by background scene complexity, under low background scene complexity conditions, target signature did not affect the time to respond. However, under medium and especially under high background scene complexity conditions, response times associated with the active target FLIR signatures were much more rapid than those associated with either of the other target signatures ($ps < .05$).

5.2.2 Recognition - Figures 5-5 through 5-9 depict the overall main effects and the target signature by background scene complexity interaction. Moreover, Tables B-36 through B-40 in Appendix B present individual comparisons. The major findings were:

(1) Response times were shorter for active target FLIR signatures than for inactive target FLIR signatures which, in turn, were shorter than for TV target signatures ($ps < .05$).

(2) Targets embedded in low complexity background scenes were responded to more rapidly than those embedded in high complexity background scenes ($p < .05$).

(3) Response times for closure rates of 1000 ft/sec were more rapid than those for closure rates of 500 ft/sec, which, in turn, were more rapid than those for closure rates of 250 ft/sec ($ps < .05$).

(4) The tank targets were responded to more rapidly than were the truck or half-track targets ($ps < .05$).

(5) Response times associated with active target FLIR signatures were more rapid than those associated with either of the other target signatures when low complexity background scenes were presented ($ps < .05$). While target signature did not affect the time to respond under the medium background scene complexity condition, for the high background scene complexity condition, response times were ordered from fastest to slowest for the active target FLIR signatures, inactive target FLIR signatures and TV target signatures, respectively ($ps < .05$).

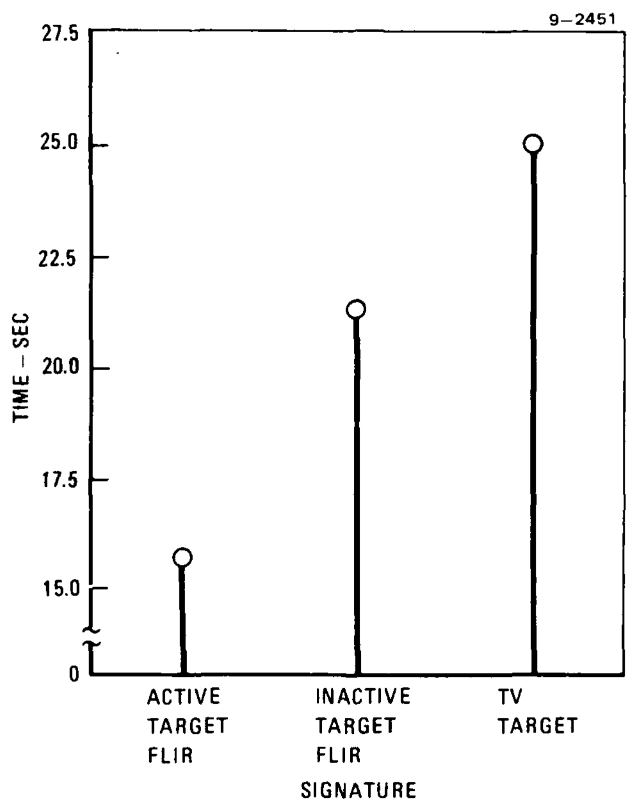


FIGURE 5–5 RESPONSE TIME TO TARGET RECOGNITION – SIGNATURE (30,000 FT INITIAL SLANT RANGE)

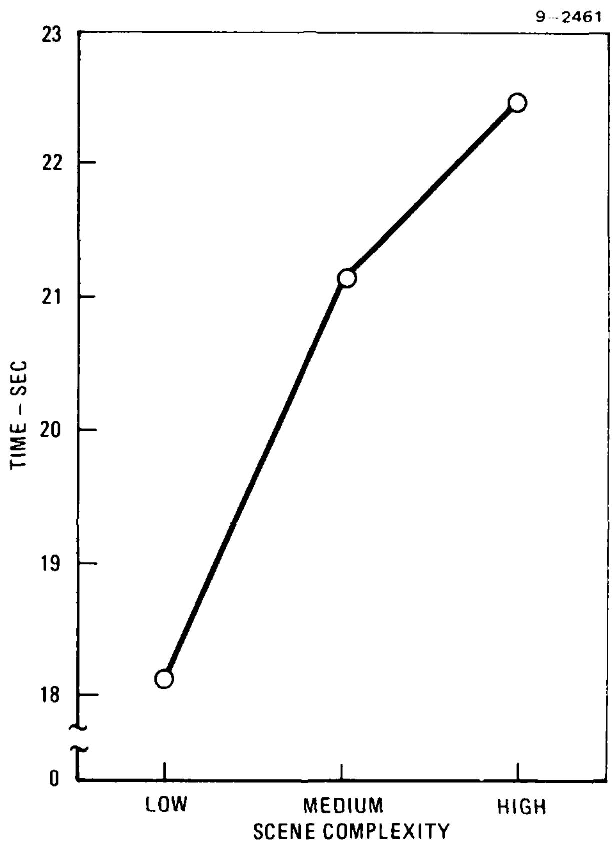


FIGURE 5–6 RESPONSE TIME TO TARGET RECOGNITION – SCENE COMPLEXITY (30,000 FT INITIAL SLANT RANGE)

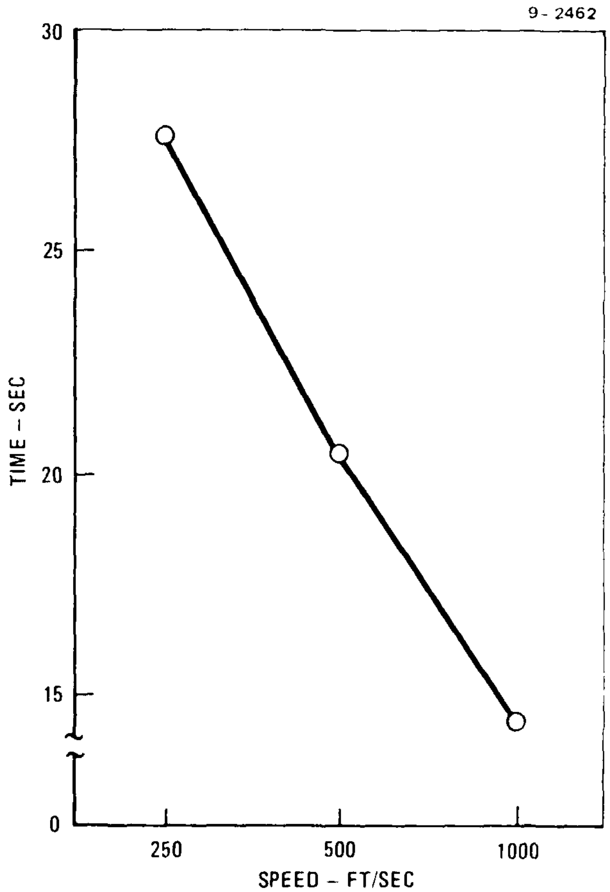


FIGURE 5–7 RESPONSE TIME TO TARGET RECOGNITION – SPEED (30,000 FT INITIAL SLANT RANGE)

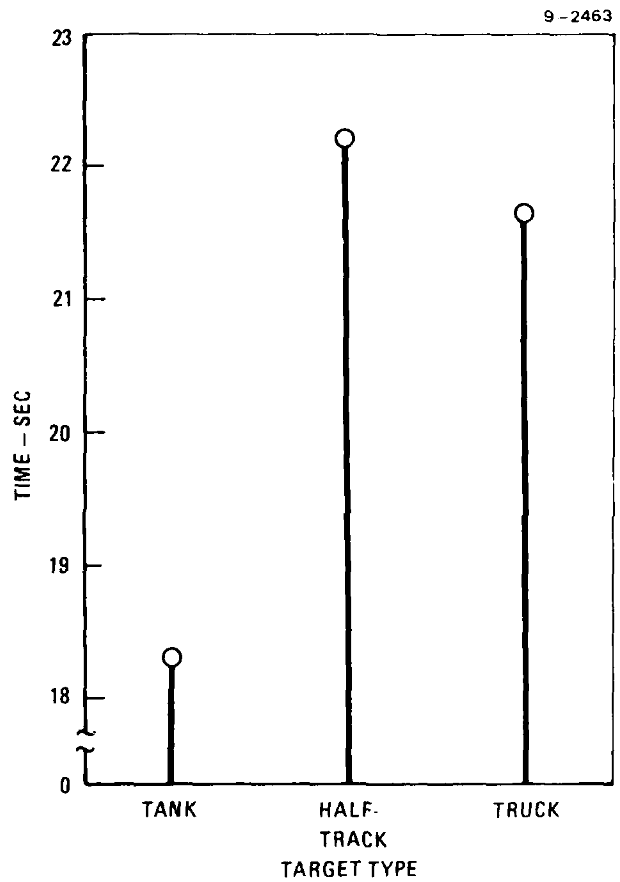


FIGURE 5–8 RESPONSE TIME TO TARGET RECOGNITION – TARGET TYPE (30,000 FT INITIAL SLANT RANGE)

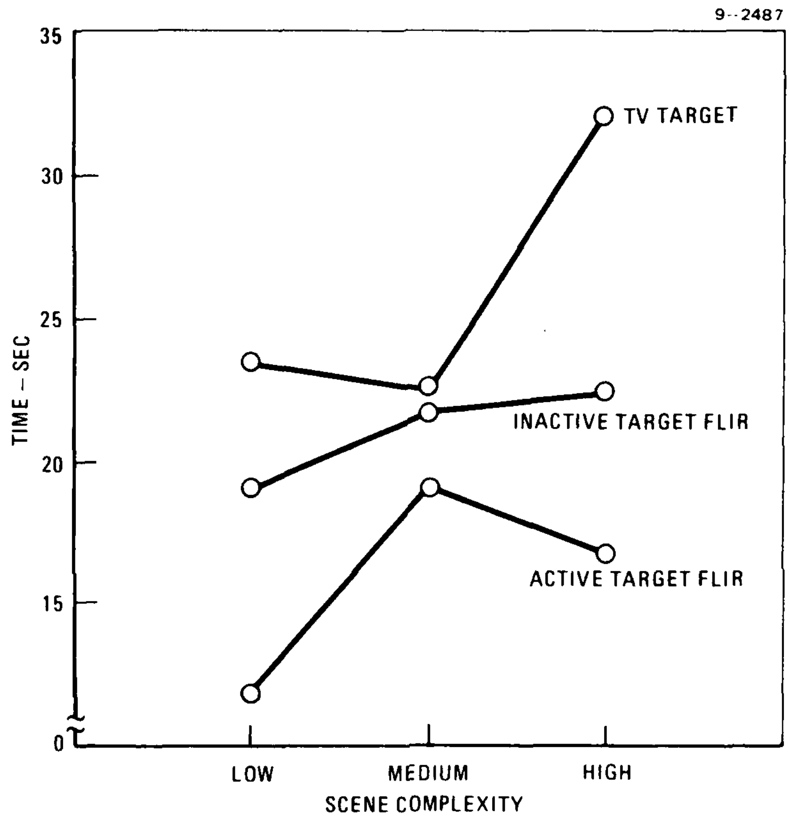


FIGURE 5–9 RESPONSE TIME TO TARGET RECOGNITION – SIGNATURE X SCENE COMPLEXITY INTERACTION (30,000 FT INITIAL SLANT RANGE)

5.3 RANGE AT DETECTION AND RECOGNITION

The range data did not require transformation. Summaries of the analyses of variance performed on the range data appear in Tables 5-3 and 5-4 for detection and recognition, respectively.

TABLE 5-3 Analysis of Variance Summary Table for the Range at Target Detection: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	283993180.9	19.3	.01	.031
SCENCOMP	2	1836392420.3	122.7	.01	.196
SPEED	2	1482336565.5	99.0	.01	.158
TGTTYP	2	27988219.5	1.9	.17	.003
SUBJECT	5	480549322.8	12.8	.01	.051
SIG X SCENCOMP	4	331019960.7	11.1	.01	.035
SIG X SPEED	4	333906838.1	11.2	.01	.037
SIG X TGTTYP	4	481935141.7	16.1	.01	.051
SCENCOMP X SPEED	4	153267040.5	5.1	.01	.016
SCENCOMP X TGTTYP	4	90758020.8	3.0	.02	.010
SPEED X TGTTYP	4	48382636.5	1.6	.18	.005
SIG X SCENCOMP X SPEED	8	814922034.0	13.6	.01	.087
SIG X SCENCOMP X TGTTYP	8	255635978.2	4.3	.01	.027
SIG X SPEED X TGTTYP	8	377721222.6	6.3	.01	.040
SCENCOMP X SPEED X TGTTYP	8	219873312.5	3.7	.01	.023
SIG X SCENCOMP X SPEED X TGTTYP	11	333210031.6	4.1	.01	.036
ERROR	241	1803986572.1			
CORRECTED TOTAL	321	9360878498.2			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.807

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 5-4 Analysis of Variance Summary Table for the Range at Target Recognition: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P	eta^2
SIG	2	693129518.1	26.0	.01	.046
SCENCOMP	2	279394045.0	10.5	.01	.019
SPEED	2	3209857257.1	120.6	.01	.214
TGTTYP	2	100339339.8	3.8	.03	.007
SUBJECT	5	2662999637.1	40.0	.01	.178
SIG X SCENCOMP	4	254842852.1	4.8	.01	.017
SIG X SPEED	4	338159395.2	6.4	.01	.023
SIG X TGTTYP	4	773061781.9	14.5	.01	.052
SCENCOMP X SPEED	4	95389967.3	1.8	.14	.006
SCENCOMP X TGTTYP	4	270247386.4	5.1	.01	.018
SPEED X TGTTYP	4	182715319.3	3.4	.01	.012
SIG X SCENCOMP X SPEED	8	965797822.3	9.1	.01	.065
SIG X SCENCOMP X TGTTYP	8	452229559.2	4.3	.01	.030
SIG X SPEED X TGTTYP	8	925264271.6	8.7	.01	.062
SCENCOMP X SPEED X TGTTYP	8	53486369.1	0.5	.86	.004
SIG X SCENCOMP X SPEED X TGTTYP	11	507285429.2	3.5	.01	.034
ERROR	241	3207786238.3			
CORRECTED TOTAL	321	14971986224.9			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.786

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

5.3.1 Detection - Overall main effects and the signature by background scene complexity interaction are illustrated in Figures 5-10 through 5-13. To further interpret the data, refer to Tables B-41 through B-45 in Appendix B. The principal results were:

(1) Stand-off range to target was greater for the active target FLIR signatures than for either the inactive target FLIR or TV target signatures ($ps < .05$).

(2) The low background scene complexity condition yielded longer stand-off ranges than either of the other two background scene complexity conditions ($ps < .05$).

(3) Slower closure rates were associated with greater stand-off ranges than were faster closure rates ($ps < .05$).

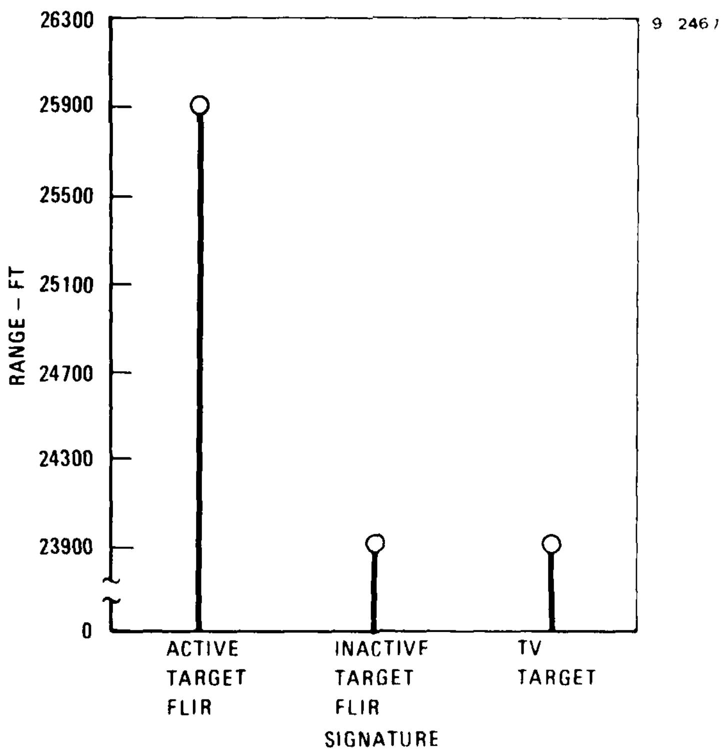


FIGURE 5–10 RANGE AT TARGET DETECTION – SIGNATURE (30,000 FT INITIAL SLANT RANGE)

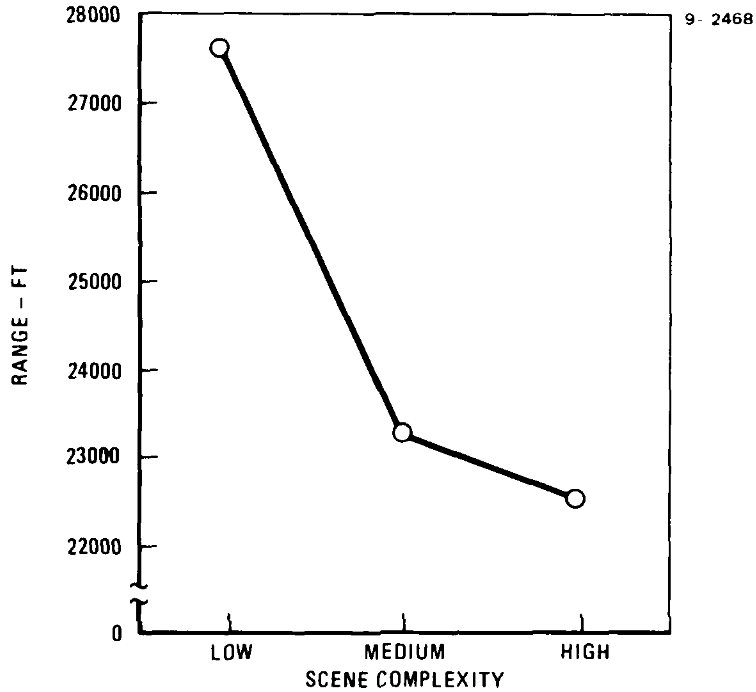


FIGURE 5–11 RANGE AT TARGET DETECTION – SCENE COMPLEXITY (30,000 FT INITIAL SLANT RANGE)

(4) For the medium background scene complexity condition, the active target FLIR signatures were associated with longer stand-off ranges than were the other signatures ($ps < .05$). For the high background scene complexity condition, the three signatures differed significantly from one another, with the active target FLIR signatures yielding the longest stand-off ranges and the TV target signatures the shortest ($ps \leq .05$). Signature did not influence range to detection for the low background scene complexity condition.

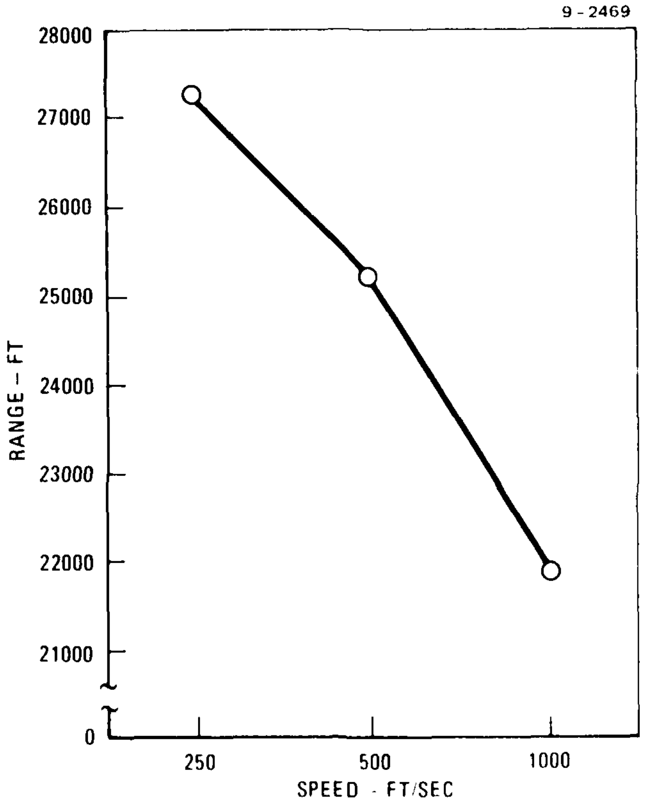


FIGURE 5–12 RANGE AT TARGET DETECTION – SPEED
(30,000 FT INITIAL SLANT RANGE)

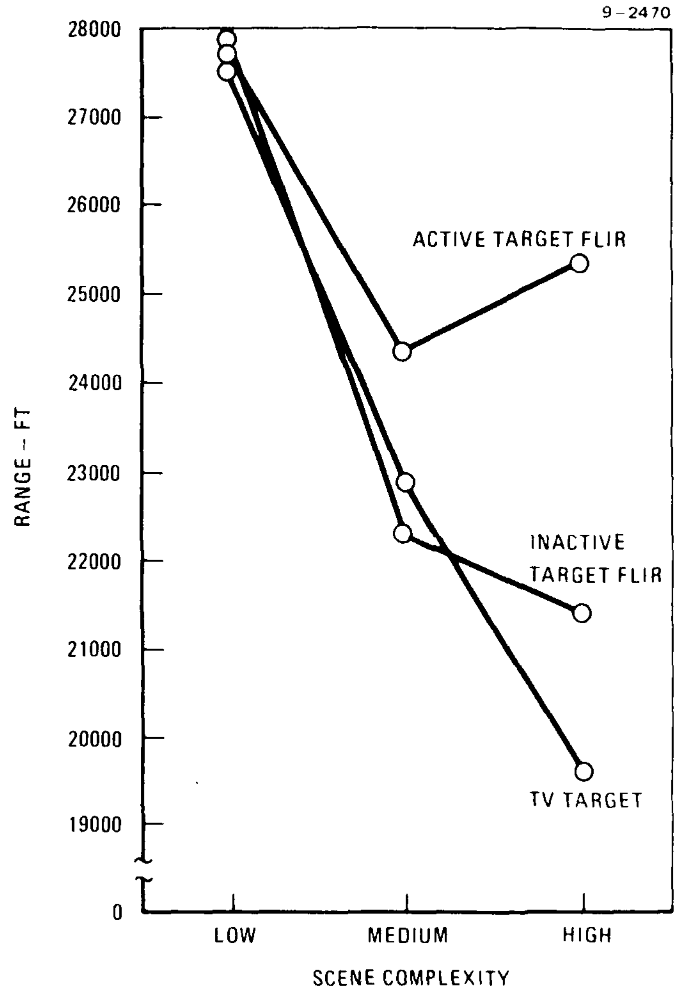


FIGURE 5–13 RANGE AT TARGET DETECTION – SIGNATURE X SCENE COMPLEXITY INTERACTION (30,000 FT INITIAL SLANT RANGE)

5.3.2 Recognition - The results concerning stand-off range at recognition are depicted in Figures 5-14 through 5-18. In Appendix B, Tables B-46 through B-50 present individual comparisons. The findings are summarized below.

(1) Stand-off ranges for the active target FLIR signatures were greater than for either the inactive target FLIR or TV target signatures (ps < .05). The latter two did not differ significantly in their effects on range to target at recognition.

(2) Stand-off ranges for the low background scene complexity condition were longer than for either the medium or high background scene complexity conditions (ps < .05), which did not differ reliably in their effects on a stand-off range.

(3) Stand-off ranges were progressively shorter as closure rate increased from 250 ft/sec through 1000 ft/sec (ps < .05).

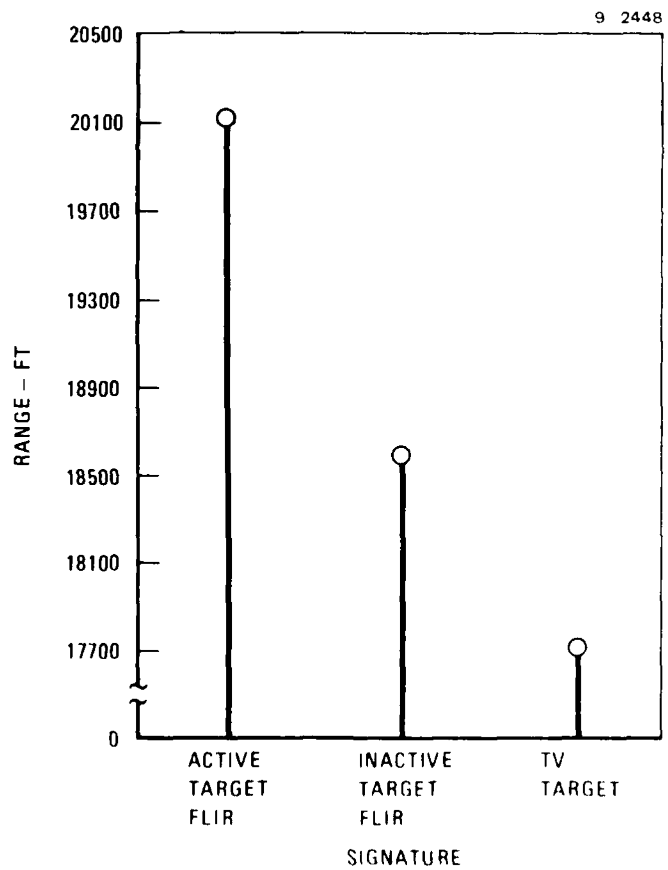


FIGURE 5–14 RANGE AT TARGET RECOGNITION – SIGNATURE (30,000 FT INITIAL SLANT RANGE)

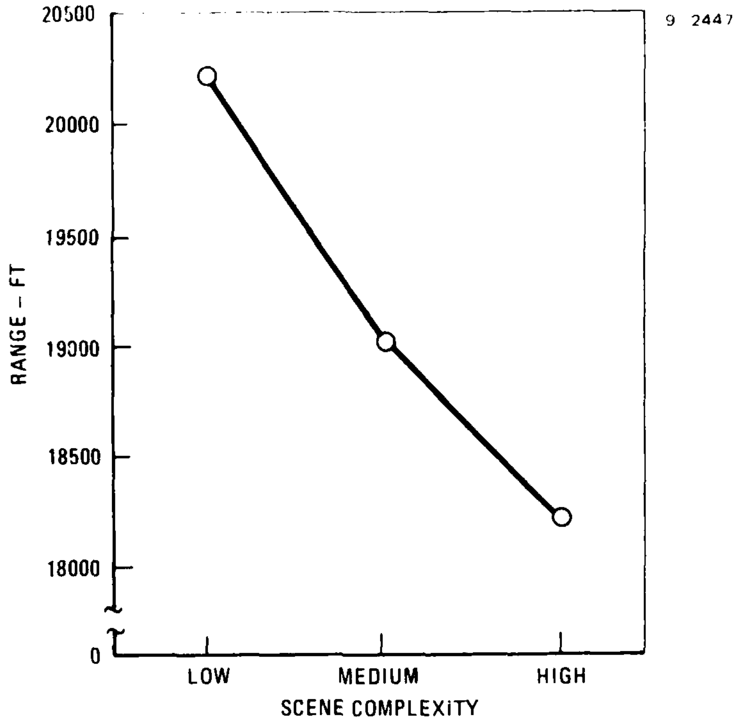


FIGURE 5–15 RANGE AT TARGET RECOGNITION – SCENE COMPLEXITY (30,000 FT INITIAL SLANT RANGE)

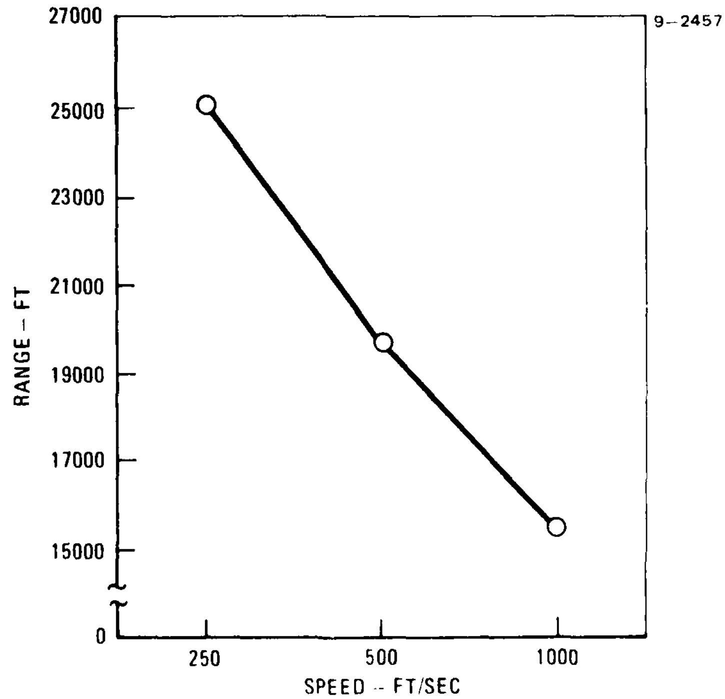


FIGURE 5–16 RANGE AT TARGET RECOGNITION – SPEED (30,000 FT INITIAL SLANT RANGE)

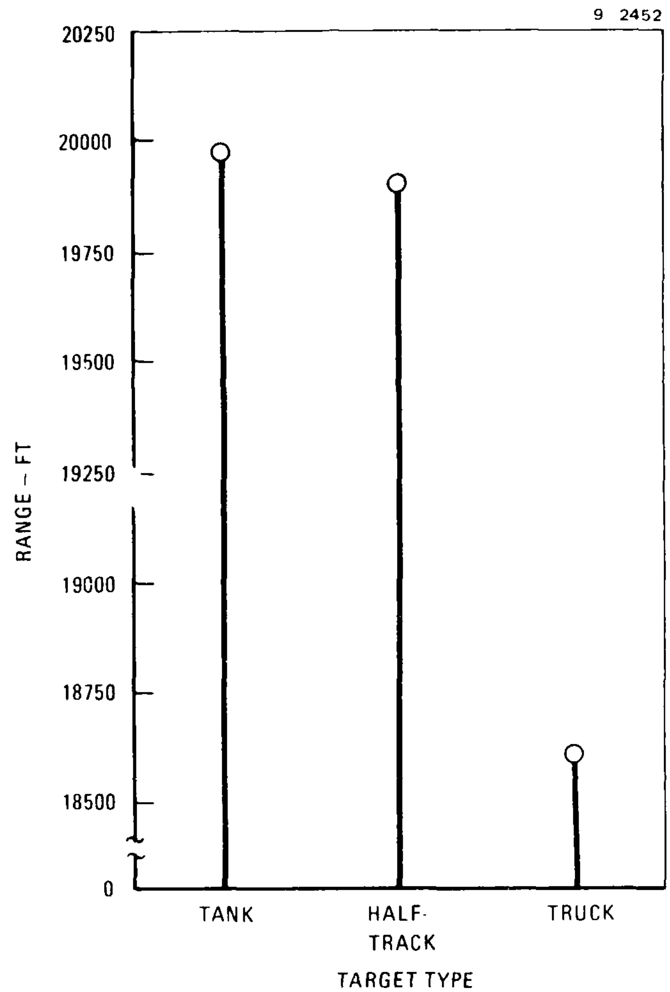


FIGURE 5–17 RANGE AT TARGET RECOGNITION – TARGET TYPE (30,000 FT INITIAL SLANT RANGE)

(4) Stand-off ranges for the tank and half-track targets did not differ significantly, however, both yielded longer stand-off ranges than did the truck targets (ps < .05).

(5) Under the high background scene complexity condition, the active and inactive target FLIR signatures were associated with longer stand-off ranges than were the TV target signatures (ps < .05). For the low background scene complexity condition, the active target FLIR signatures were associated with longer stand-off ranges than were the other signatures (ps < .05). Target signature did not affect range to target at recognition for the medium background scene complexity condition.

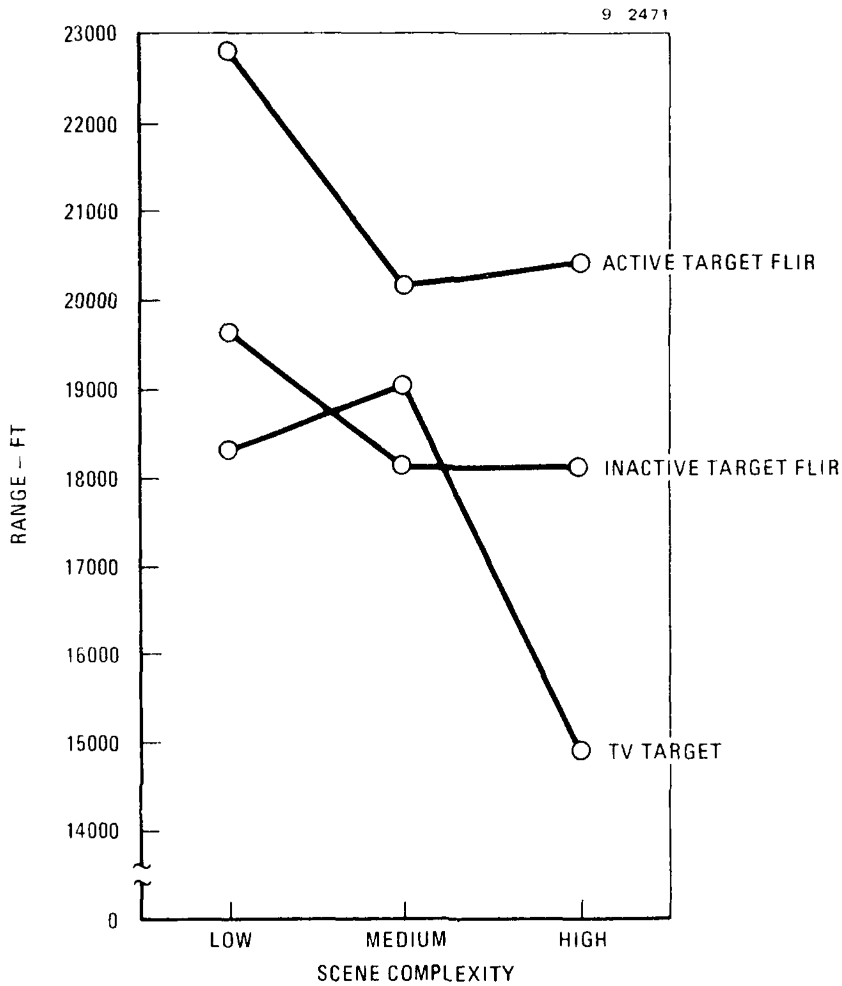


FIGURE 5–18 RANGE AT TARGET RECOGNITION – SIGNATURE X SCENE COMPLEXITY INTERACTION (30,000 FT INITIAL SLANT RANGE)

5.4 TARGET SIZE AT DETECTION AND RECOGNITION

Summaries of the analyses of variance for target width on the display at detection and recognition are contained in Tables 5-5 and 5-6, respectively. The size data recorded in terms of target width were quite similar to the range data. Therefore, we refer the reader to Tables B-51 through B-60 in Appendix B for a detailed presentation of the results.

5.5 IMAGE DYNAMICS - TIME AND RANGE

For our sensor simulation, aircraft velocity determined image dynamics, in that the velocity directly influenced the rate of expansion and migration for

TABLE 5-5 Analysis of Variance Summary Table for the Target Width at Target Detection: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	.01107	7.0	.01	.014
SCENCOMP	2	.14495	91.9	.01	.186
SPEED	2	.07810	49.5	.01	.101
TGTTYP	2	.04348	27.6	.01	.056
SUBJECT	5	.02225	5.6	.01	.028
SIG X SCENCOMP	4	.03163	10.0	.01	.040
SIG X SPEED	4	.00761	2.4	.05	.010
SIG X TGTTYP	4	.05284	16.8	.01	.068
SCENCOMP X SPEED	4	.02615	8.3	.01	.033
SCENCOMP X TGTTYP	4	.00565	1.8	.14	.007
SPEED X TGTTYP	4	.00474	1.5	.21	.006
SIG X SCENCOMP X SPEED	8	.05052	8.0	.01	.065
SIG X SCENCOMP X TGTTYP	8	.02244	3.6	.01	.029
SIG X SPEED X TGTTYP	8	.04925	7.8	.01	.063
SCENCOMP X SPEED X TGTTYP	8	.01644	2.6	.01	.021
SIG X SCENCOMP X SPEED X TGTTYP	11	.02539	2.9	.01	.037
ERROR	239	.18845			
CORRECTED TOTAL	319	.78116			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.759

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

TABLE 5-6 Analysis of Variance Summary Table for the Target Width at Target Recognition: 30,000 Ft Initial Slant Range

SOURCE	df	SUM OF SQUARES	F	P<	eta^2
SIG	2	.08945	14.0	.01	.038
SCENCOMP	2	.08455	13.2	.01	.036
SPEED	2	.41393	64.6	.01	.176
TGTTYP	2	.03265	5.1	.01	.014
SUBJECT	5	.23865	14.9	.01	.101
SIG X SCENCOMP	4	.05831	4.6	.01	.025
SIG X SPEED	4	.03875	3.0	.02	.016
SIG X TGTTYP	4	.14806	11.6	.01	.063
SCENCOMP X SPEED	4	.01904	1.5	.21	.008
SCENCOMP X TGTTYP	4	.01385	1.1	.37	.006
SPEED X TGTTYP	4	.03486	2.7	.04	.015
SIG X SCENCOMP X SPEED	8	.10658	4.2	.01	.045
SIG X SCENCOMP X TGTTYP	8	.07363	2.9	.01	.031
SIG X SPEED X TGTTYP	8	.14822	5.8	.01	.063
SCENCOMP X SPEED X TGTTYP	8	.01908	0.7	.66	.008
SIG X SCENCOMP X SPEED X TGTTYP	11	.06766	1.9	.04	.029
ERROR	239	.76622			
CORRECTED TOTAL	319	2.35355			

TOTAL VARIANCE ACCOUNTED FOR (R^2)=.674

ABBREVIATIONS OF VARIABLE NAMES

SIG - SIGNATURE

SCENCOMP - SCENE COMPLEXITY

TGTTYP - TARGET TYPE

images on the display (see Figure 5-19). At the start of a trial with a velocity of 250 ft/sec, the scene appears almost static, that is, there is very little display motion. However, at a closure rate of 1000 ft/sec, there is a noticeable change in the displayed image, with the target expanding in size and migrating to the side of the FOV. As shown in Figure 5-20, response time decreases absolutely with increasing closure rate. What is particularly surprising, however, is that detection and recognition times for the 1000 ft/sec closure rate are actually quite long when one considers the resultant ranges to target at detection and recognition. From examination of the range data in Figure 5-20, it can be seen that the stand-off range at both detection and recognition is markedly shorter for the 1000 ft/sec rate than for the 250 ft/sec rate. In fact, the range to target for recognition at the 250 ft/sec rate is greater than the range to target for detection for the 1000 ft/sec rate.

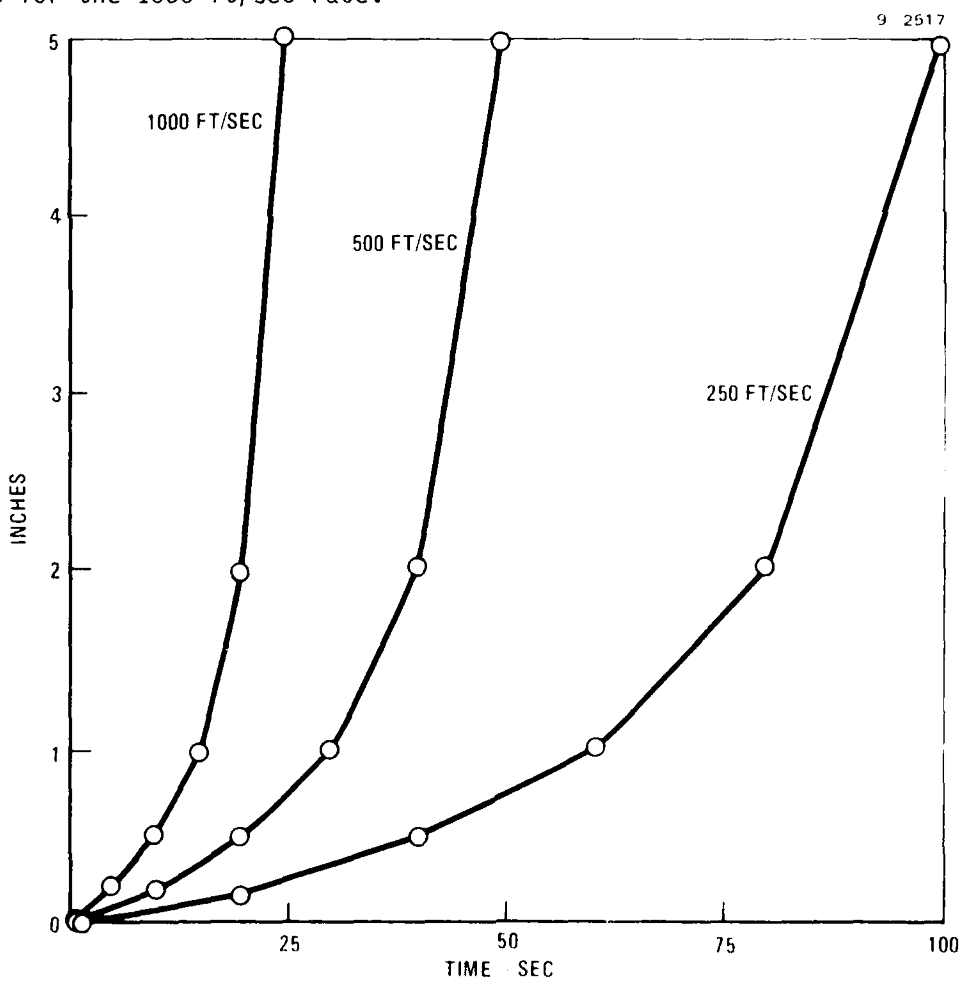


FIGURE 5–19 MIGRATION OF A SPOT TARGET ACROSS THE DISPLAY (TIME IS REFERENCED TO THE START OF THE TRIAL)

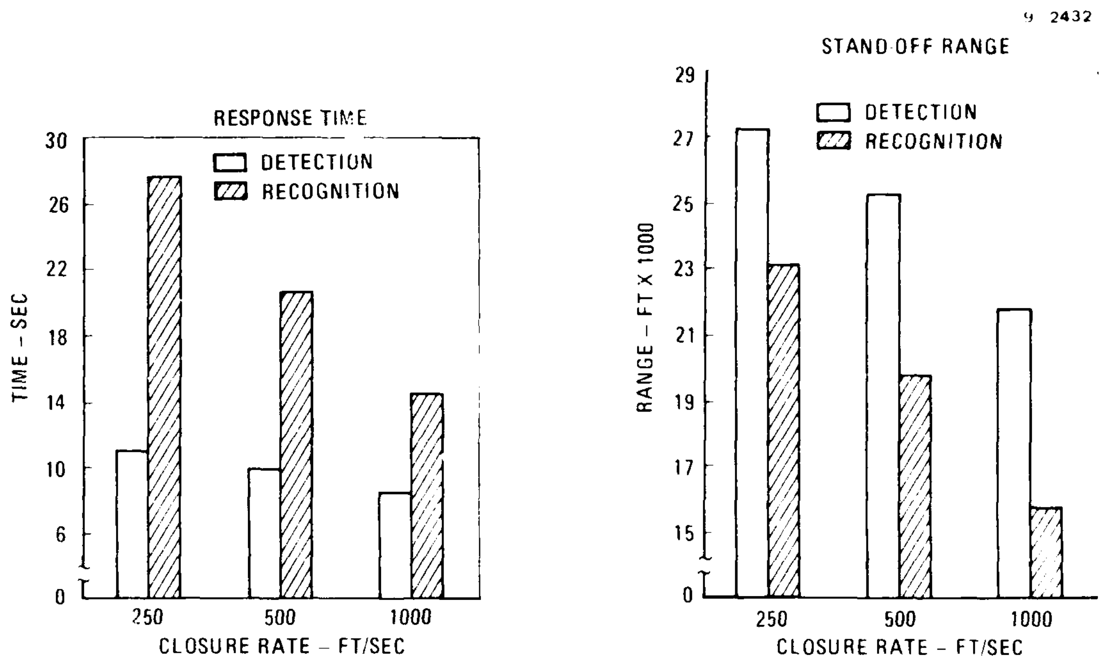


FIGURE 5–20 IMAGE DYNAMICS – TIME AND RANGE

Figure 5-21 presents the data in a different manner, showing target size on display at detection and recognition. The displayed target images were clearly suprathreshold with respect to size (assuming no interference effects due to the background scene) well before detection occurred, particularily at the faster closure rates. We suspect that the greater relative motion for the 1000 ft/sec rate caused the subjects to change their criteria for response, perhaps due to a motion induced perceptual set. Referring to Figure 5-19, it is doubtful, especially during the first 15 seconds of a trial, that the rates of display motion exceeded the limits of the human visual system to process dynamic information.

5.6 DESCRIPTIVE MODELS OF OPERATOR PERFORMANCE

The response time data were analyzed with a linear multiple regression program which used a stepwise variable selection procedure. The analyses generated descriptive models of operator performance for both detection and recognition within the context of narrow FOV, ground-stabilized imaging sensor systems. Although the stimulus events, i.e., terrain, target, and image dynamics, were quite realistic for Air Force attack missions, we remind the reader as he reviews the descriptive models that the operators were responsible only for target acquisition; no additional task demands or environmental stressors were introduced.

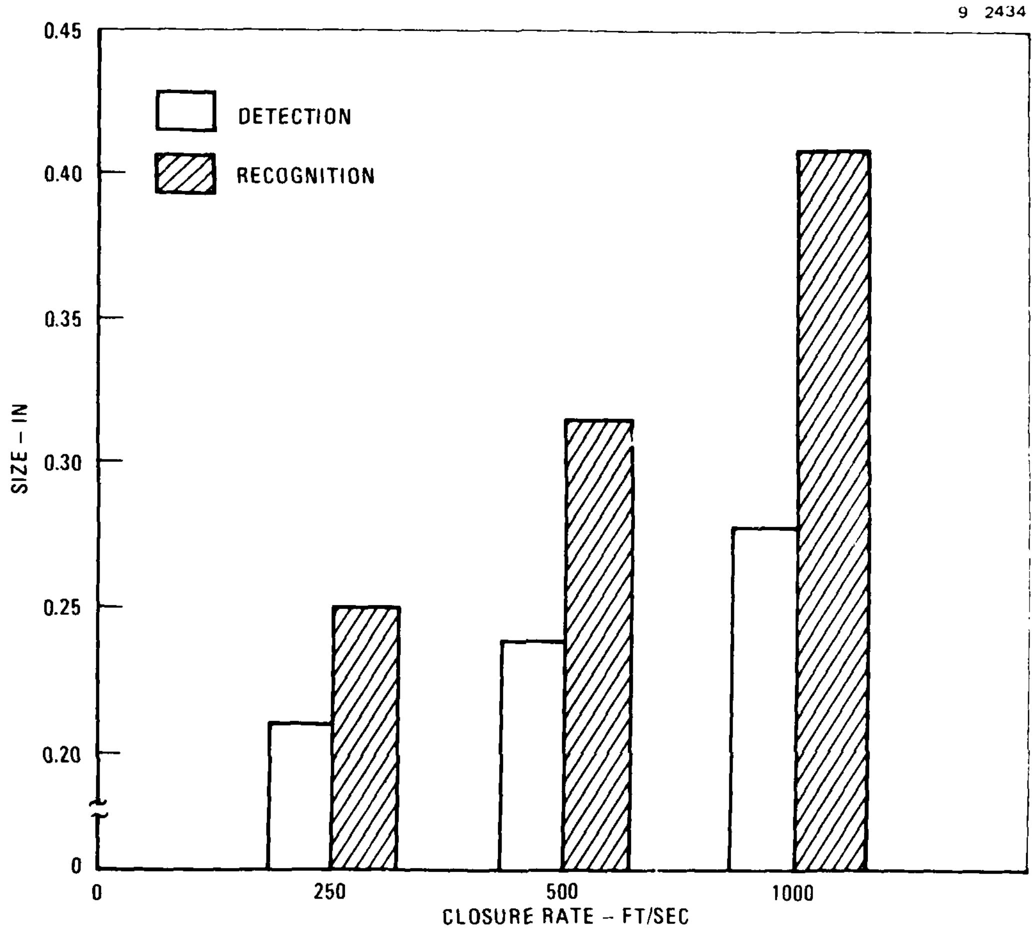


FIGURE 5–21 IMAGE DYNAMICS – TARGET SIZE ON DISPLAY

Greening (1973, 1974), in a comprehensive review of target acquisition models, organized disparate approaches into distinct dimensional categories which took the form of continua. The dimensional categories were:

1. Analytic----Synthetic----Data-based
2. Scientific---------------Utilitarian
3. Optical/Objective--------Cognitive/Subjective
4. Comprehensive------------Reductive
5. Target-centered----------Situation-centered.

Our approach may be defined as eclectic since it applies to multiple regions of different continua. For example, although an analytic approach was assumed, clearly a data-based approach was employed when determining which variables would be entered into the models. The models have scientific merit, but also are utilitarian since the experiments were designed within an operational context.

Although we are aware of the tremendous influence that cognitive variables have on detection and recognition processes, we have emphasized sensor/display system variables within these models. Due to the relatively limited number of variables which were entered, the models must be considered reductive. Finally, both target- and situation-centered (e.g., background scene complexity) factors were addressed.

5.6.1 Exploratory Model Development - As noted earlier, a stepwise regression procedure was chosen for our exploratory model development. Further, a maximum R^2 improvement (MAXR) method was applied for the selection of variables which entered the models. This particular regression procedure does not produce a "single" model. Rather, it defines the best one-variable model, the best two-variable model, etc., the criterion being that the resultant models account for the greatest variance. After the single variable which accounts for the most variance is identified, the variable which yields the greatest increase in R^2 when combined with the first variable is added. Following the formulation of the two-variable model, each of the remaining variables is compared to the model variables to determine whether the removal of one model variable and its replacement with another variable would increase R^2. Comparisons continue until it is determined that no substitution would increase R^2, i.e., the best two-variable model is achieved. The process is then repeated to obtain the "best" three-variable model, and so on.

5.6.2 Variables - The variables which had a significant effect on performance in the experiments, i.e., target signature, target type, background scene complexity, and closure rate, were entered into the overall models for detection and recognition. Also, individual models were developed for each level of background scene complexity. Vectors to account for individual operator effects were forced into all models to minimize the influence of subject variability. Additionally, since our review of the literature had indicated that target size and target/background luminance dramatically affect performance, we examined different measures for these variables as well.

5.6.2.1 Target Size - Several size measures were recorded on a trial-by-trial basis. As represented in Figure 5-22, these measures included: target length, target width, horizontal extent on the display, vertical extent on the

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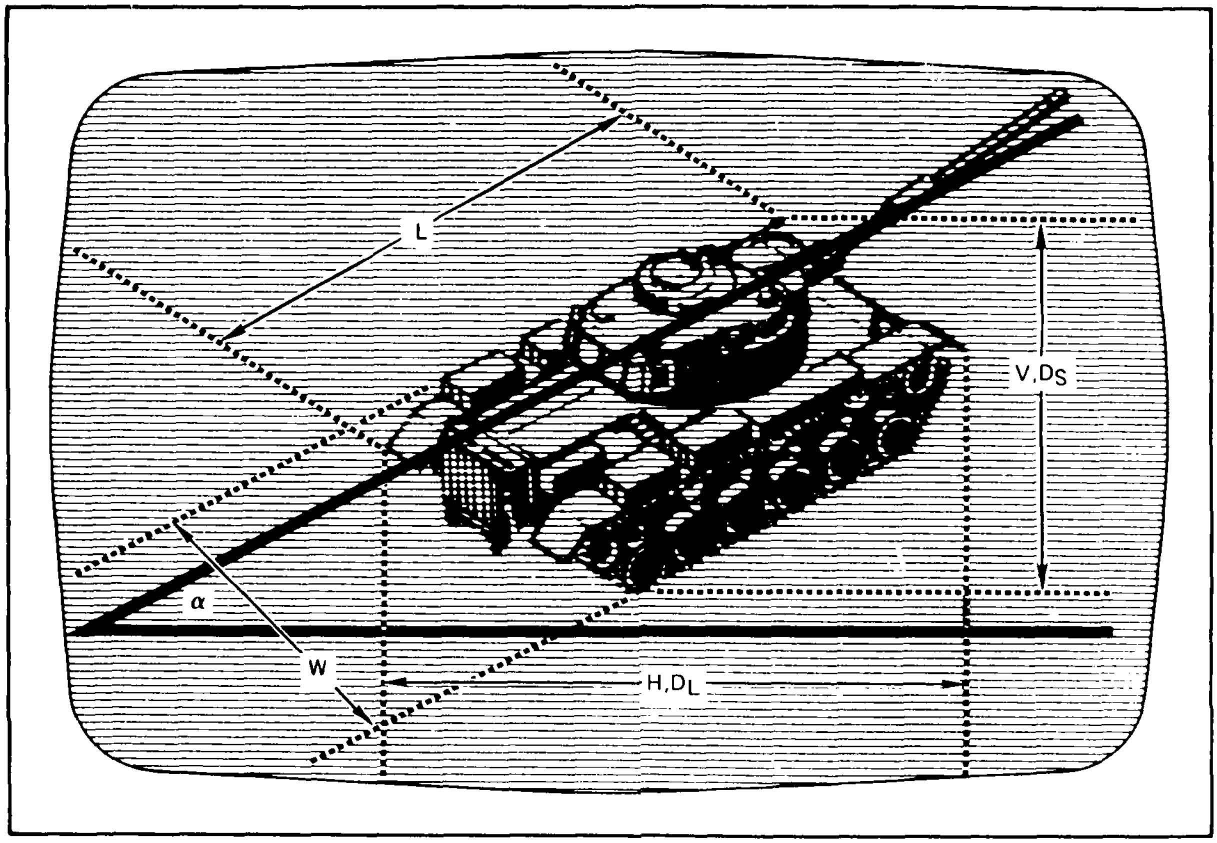

L – LENGTH OF THE TARGET
W – WIDTH OF THE TARGET
H – HORIZONTAL TARGET DIMENSION, MEASURED PARALLEL TO TV RASTER LINES
V – VERTICAL TARGET DIMENSION, MEASURED PERPENDICULAR TO TV RASTER LINES
D_L – LONG DIAGONAL TARGET DIMENSION, MEASURED CORNER TO CORNER ACROSS THE TARGET AXIS
D_S – SHORT DIAGONAL TARGET DIMENSION, MEASURED CORNER TO CORNER ACROSS THE TARGET AXIS (CORNER NOT USED IN D_L)
α – THE ANGLE OF THE MAJOR TARGET AXIS IN RELATION TO THE RASTER LINES

NOTE: FOR THE TARGET ORIENTATION SHOWN IN THE FIGURE (α 45°) H IS EQUAL TO D_L AND V IS EQUAL TO D_S. THESE VALUES DEVIATE FROM ONE ANOTHER AT OTHER TARGET ORIENTATIONS.

FIGURE 5–22 TARGET SIZE MEASURES

display, short diagonal, and long diagonal. Preliminary stepwise regression analyses restricted to the six size measures alone demonstrated that target width and target length were the best predictors of performance. Therefore, these two size measures were selected for inclusion in the models.

5.6.2.2 Target/Background Luminance - Ten display luminance readings (four within the target and six from the immediate background scene) were taken with a Pritchard Spot Photometer for each target at a stand-off range equivalent to the mean of the group for recognition. These readings provided measures of:

(a) the most luminous area within the target (TGTB)
(b) the least luminous area within the target (TGTD)
(c) average target luminance (TGTA)
(d) the most luminous area within the background (BGB)
(e) the least luminous area within the background (BGD)
(f) average background luminance (BGA)

These measures were entered into all regression models that we report. In addition, all possible combinations (15) of these measures were examined in separate stepwise regressions as well. The combinations were abbreviated as follows:

L1 = TGTB/TGTD	L9 = TGTB/BGA
L2 = TGTB/TGTA	L10 = BGB/TGTA
L3 = TGTA/TGTD	L11 = TGTA/BGD
L4 = BGB/BGD	L12 = TGTA/BGA
L5 = BGB/BGA	L13 = BGB/TGTD
L6 = BGA/BGD	L14 = TGTD/BGD
L7 = TGTB/BGB	L15 = BGA/TGTD
L8 = TGTB/BGD	

Table 5-7 presents the metrics selected for the overall models (background scene complexity was a variable in the model) and for the models limited to a particular level of background scene complexity.

5.6.3 Results - Summaries of the multiple regressions performed on the response time data at detection and recognition appear in Tables 5-8 through 5-15. Background scene complexity is included as a variable in the models presented in Tables 5-8 and 5-9. The models developed for each class of response as a function of the level of background scene complexity are contained in Tables 5-10 through 5-16. Recall that the scheme for abbreviating the luminance measures is presented in Section 5.6.2.2. The descriptive models of operator performance have the general form:

$$Y = B_0 + B_1X_1 + B_2X_2 + \dots B_NX_N + E.$$

The R^2 values reported in the tables are cumulative.

TABLE 5-7 Luminance Metrics Chosen for Inclusion in the Regression Model

	Background Scene Complexity	Metrics						R^2
Target Detection	Variable Included in Model	L2	L3	L7	L9	L13	L15	0.169
Target Recognition	Variable Included in Model	L2	L3	L7	L12	L13	L15	0.089
Target Detection	Low	L4	L5	L6	L10	L13	L15	0.094
	Medium	L3	L4	L5	L6	L10	L13	0.342
	High	L1	L3	L4	L6	L7	L11	0.360
Target Recognition	Low	L2	L3	L7	L9	L12	L13	0.263
	Medium	L4	L6	L8	L9	L13	L15	0.284
	High	L2	L5	L6	L7	L11	L15	0.309

Abbreviations

L1 =	TGTB/TGTD	L9 =	TGTB/TGTA
L2 =	TGTB/TGTA	L10 =	BGB/TGTA
L3 =	TGTA/TGTD	L11 =	TGTA/BGD
L4 =	BGB/BGD	L12 =	TGTA/BGA
L5 =	BGB/BGA	L13 =	BGB/TGTD
L6 =	BGA/BGD	L14 =	TGTD/BGD
L7 =	TGTB/BGB	L15 =	BGA/TGTD
L8 =	TGTB/BGD		

TABLE 5-8 Summary of Multiple Regression of Response Time to Detection: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	0.39	1.39	0.004
Target Width	118.90	165.70	0.346
Speed	-0.01	64.13	0.456
Scene Complexity	2.09	14.80	0.481
Signature	1.55	9.28	0.496
Target Length	16.35	4.95	0.504
BGB	-0.07	2.29	0.507
L9	-10.46	4.23	0.514
L15	-0.31	3.31	0.519
L7 Replaced BGB	4.41	4.50	0.519
BGA Replaced L15	-0.05	9.89	0.527
TGTB Replaced L7	0.35	15.24	0.535
L7	3.82	2.41	0.539
BGD	-0.08	1.59	0.541
L2	-3.83	1.71	0.544
TGTA Replaced BGD	-0.29	7.42	0.551
BGD	-0.09	2.21	0.554
TGTD	0.04	0.25	0.555
L13	1.15	0.77	0.556
L15	-0.24	0.17	0.556
Target Type	-0.15	0.10	0.556
L3	1.05	0.09	0.556
BGB	-0.02	0.01	0.556

TABLE 5-9 Summary of Multiple Regression of Response Time to Recognition: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	0.91	3.61	0.011
Target Width	62.69	48.85	0.143
Speed	-0.03	187.17	0.462
Target Type	2.47	12.56	0.483
Signature	2.16	8.26	0.496
Target Length Replaced Target Type	22.90	12.26	0.497
Target Type	1.80	6.44	0.507
BGD	-0.21	5.51	0.516
L7	2.76	1.49	0.518
L15	0.14	0.48	0.519
TGTD	0.09	0.77	0.520
TGTA	-0.02	0.19	0.520
L2	-3.51	0.31	0.521
BGB Replaced TGTD	0.28	2.08	0.523
TGTD	0.20	1.80	0.525
BGA	-0.01	0.27	0.526
L3 Replaced TGTD	-2.66	2.56	0.527
L13 Replaced BGA	3.40	1.14	0.527
Scene Complexity Replaced L15	-1.39	1.24	0.528
TGTB	0.15	0.20	0.528
L15	0.18	0.15	0.528
BGA Replaced TGTB	-0.02	0.23	0.528
TGTB	0.16	0.21	0.529
TGTD	-0.13	0.10	0.529
L12	-2.79	0.05	0.529

TABLE 5-10 Summary of Multiple Regression of Response Time to Detection for Low Scene Complexity: 30,000 Ft Initial Slant Range

VARIABLE	B	F TO ENTER	MULTIPLE R^2
Subject	0.04	0.07	0.001
Target Width	79.31	19.97	0.153
L15	0.07	4.13	0.184
L10	-3.90	9.46	0.249
Speed	-0.01	3.99	0.276
Signature	0.42	1.88	0.288
Target Type	0.28	1.04	0.295
TGTA Replaced L10	0.13	15.24	0.300
Target Length Replaced Speed	-6.87	1.90	0.303
Speed	-0.00	1.24	0.311
TGTB	-0.03	0.24	0.313
L13	0.63	0.32	0.315
L10	-1.00	0.12	0.316
BGA Replaced L15	0.01	1.40	0.317
L5	5.28	0.09	0.317
BGB Replaced TGTA	-0.38	1.16	0.324
L15	-0.32	0.15	0.325
TGTA	0.07	0.20	0.327
BGD	-0.01	0.10	0.327
L4 Replaced TGTA	-0.31	0.82	0.332
L6 Replaced Target Length	1.95	6.77	0.367
TGTA Replaced L10	0.12	5.67	0.372
TGTD Replaced TGTB	0.19	0.50	0.373
TGTB	-0.04	0.32	0.375
Target Length	0.69	0.01	0.375
L10	-0.01	0.00	0.375

ABLE 5-11 Summary of Multiple Regression of Response Time to Detection for Medium Scene Complexity: 30,000 Ft Initial Slant Range

'ARIABLE	B	F TO ENTER	MULTIPLE R^2
ubject	0.09	0.02	0.000
'arget Width	122.59	39.56	0.282
peed	-0.02	42.36	0.495
.5	56.50	24.10	0.594
.3	-3.78	12.25	0.639
'GTB	0.13	4.63	0.656
'GTA	-0.11	7.21	0.680
.13 Replaced L3	-3.26	16.57	0.690
'arget Length	-28.78	3.50	0.701
ignature	1.04	1.44	0.706
GD	-0.18	1.11	0.709
.4 Replaced L13	-3.38	21.71	0.720
.6 Replaced Signature	1.48	2.22	0.724
'arget Type	0.87	1.33	0.728
'GTD	0.19	1.22	0.731
3 Replaced Target Type	19.30	7.74	0.747
GB Replaced L6	0.34	4.29	0.748
6	1.44	2.01	0.754
10	-6.99	1.19	0.757
ignature	-0.23	0.92	0.760
arget Type	0.30	0.11	[illegible]
13	3.64	0.11	[illegible]
GA Replaced Signature	-0.05	0.28	[illegible]
ignature	0.28	0.02	

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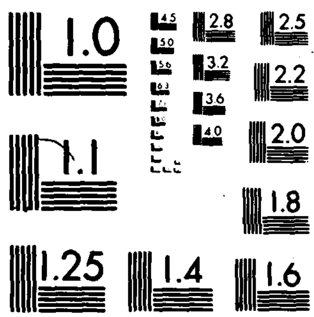

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 5-12 Summary of Multiple Regression of Response Time to Detection for High Scene Complexity: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	0.90	1.68	0.017
Target Length	48.64	37.69	0.288
Speed	-0.02	33.63	0.470
L3	4.63	10.57	0.522
BGB	-0.27	9.16	0.563
L1	-13.86	5.50	0.587
L6	1.48	3.23	0.601
Signature	2.50	2.70	0.612
TGTB	0.10	0.88	0.616
TGTA Replaced Signature	-1.23	7.40	0.631
TGTD Replaced BGB	1.55	8.39	0.657
Target Width	-66.82	4.37	0.673
BGB	-0.11	0.94	0.676
L7 Replaced Target Width	-47.07	5.85	0.678
Target Width	-75.23	4.69	0.694
L11 Replaced L6	2.48	9.88	0.702
BGD	-1.53	10.48	0.708
L4	-16.49	4.33	0.722
Signature	1.78	0.86	0.725
L6	0.41	0.06	0.725
BGA Replaced Signature	-0.90	2.44	0.730
Signature	2.09	1.14	0.733
Target Type	-0.44	0.10	0.734

TABLE 5-13 Summary of Multiple Regression of Response Time to Recognition for Low Scene Complexity: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	0.35	0.20	0.002
Target Width	81.46	28.52	0.206
Speed	-0.02	40.41	0.419
L3	7.53	14.50	0.487
Target Type	3.00	6.66	0.517
BGA	0.08	3.95	0.534
BGD	-0.28	5.24	0.556
Signature	1.73	2.03	0.565
L9 Replaced L3	87.83	12.66	0.586
L13	2.66	3.82	0.601
L12	27.39	1.99	0.608
TGTA Replaced L13	-0.86	5.90	0.609
TGTB Replaced L9	0.67	8.59	0.611
TGTD	-0.49	2.37	0.619
L2 Replaced Signature	-88.71	6.24	0.626
Signature	2.25	1.70	0.632
L9	-99.72	0.58	0.635
L3	-6.99	0.68	0.637
L13	4.45	0.55	0.639
L7 Replaced L9	81.97	8.41	0.666
BGB Replaced L12	1.82	3.41	0.675
Target Length Replaced BGA	10.63	0.92	0.678
L9	-4.89	0.03	0.678
BGA Replaced Target Type	-0.31	1.68	0.680
L12	61.06	0.52	0.682
TGTTYP	0.51	0.13	0.683

TABLE 5-14 Summary of Multiple Regression of Response Time to Recognition for Medium Scene Complexity: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	0.96	1.20	0.012
Speed	-0.02	28.08	0.227
Target Width	156.72	97.08	0.608
TGTA	-0.09	3.75	0.622
L15	-0.65	3.34	0.634
BGB	0.23	4.13	0.649
TGTB	0.24	3.90	0.663
L6	0.39	1.60	0.669
L13 Replaced BGB	4.70	4.46	0.671
L4	-12.62	5.17	0.688
BGD	0.64	2.50	0.696
Target Length	29.74	2.71	0.705
Target Type	1.23	1.07	0.708
BGA	-0.05	0.32	0.709
L8 Replaced Target Type	-10.96	2.33	0.713
Target Type	1.46	1.48	0.718
Signature	-3.21	1.67	0.723
BGB	0.55	1.77	0.728
L9 Replaced Target Width	-155.91	5.20	0.734
TGTD	0.65	1.94	0.740
Target Width	-8.33	0.03	0.740

TABLE 5-15 Summary of Multiple Regression of Response Time to Recognition for High Scene Complexity: 30,000 Ft Initial Slant Range

VARIABLE	β	F TO ENTER	MULTIPLE R^2
Subject	1.47	3.06	0.030
Speed	-0.02	24.18	0.220
Target Length	41.64	54.43	0.499
Signature	4.85	13.73	0.561
L11	1.67	3.39	0.576
L15	0.94	0.66	0.579
L6	-3.41	1.68	0.586
Target Type	1.35	1.19	0.591
L5	-18.09	2.61	0.603
L7	-8.02	0.92	0.606
L2	47.76	0.56	0.609
BGD	-0.20	0.18	0.610
BGA Replaced L2	0.40	2.26	0.619
TGTA Replaced L7	-0.62	3.97	0.625
Target Width Replaced Signature	-80.01	7.83	0.642
Signature	2.07	1.00	0.646
TGTD	0.52	1.40	0.651
BGB	0.87	1.18	0.656
TGTB	0.33	1.23	0.661
L2 Replaced BGA	-524.30	14.21	0.686
L7 Replaced BGD	-42.40	1.89	0.693
BGA	-0.08	0.10	0.693
BGD	0.10	0.00	0.693

Several findings are particularly noteworthy. (1) As presented in Tables 5-8 and 5-9, the background scene complexity variable entered the detection model at step four, however, for the recognition model, the same variable entered the model at step fourteen. These data indicate that background scene complexity has a greater impact on target detection than on target recognition. This conclusion is further supported by the eta^2 analyses presented in Tables 5-1 and 5-2. (2) Target size accounted for significant proportions of the variance for both detection and recognition.
(3) The importance of considering background scene complexity in the development of target acquisition models is evident. The models developed for the medium and high background scene complexity conditions accounted for a greater proportion of the total variance than the models that simply included background scene complexity as a variable. (4) The luminance distribution within the target, within the background, and the contrast between the target and background affect target acquisition performance.

6.0 GENERAL CONCLUSIONS

The intent of the three year program has been to examine detection and recognition processes of experienced observers viewing dynamic sensor imagery (FLIR vs. TV). As a first step, techniques were successfully developed to simulate the image dynamics of ground-stabilized, narrow FOV FLIR and TV sensor systems. Further, the operational characteristics of certain attack aircraft and imaging missiles led us to examine initial slant ranges to target following a pop-up maneuver of 5,000, 15,000, and 30,000 ft.

Generally, comparison of operator performance for simulated IR vs. TV imagery indicates the facilitating effect of IR signatures for both detection and recognition. This finding is particularly interesting in that we simulated optimal visibility conditions with no significant atmospheric attenuation or distortion of energy received by the imaging sensor. Operators responded more quickly and at greater stand-off ranges to IR imagery in comparison to TV imagery, particularly to the "hot" IR targets. These facilitating effects appear to be enhanced as background scene complexity increases.

The data from the 30,000 ft. experiment provided insight into an important issue regarding to the effectiveness of IR "hot spots" as an aid to the target acquisition process. That is, we were able to determine whether a FLIR image of an active target merely provides contrast enhancement which reduces visual search time during detection, or whether the distribution of luminance differences within the target provides a potent spatial cue for recognition as well. If we assume "hot spots" facilitate detection only, then the operator must depend principally upon differences in contour, shape, and internal detail to distinguish among quite similar tactical targets. Additionally, if the image quality and scale are the same for both sensor systems, as was the case in our simulation, then the range to target at recognition should be virtually identical whether the targets are imaged by an IR or by a TV sensor. However, we found that the stand-off ranges associated with recognition were greater for IR than for TV targets. Therefore, we concluded that the luminance distributions within the different targets served as an important cue for recognition. This was confirmed independently when the performance data were subjected to a stepwise multiple regression analysis to identify those factors having the greatest impact on target detection and recognition.

It is important to reemphasize our findings regarding operator performance as a function of aircraft closure rate. Aircraft velocity determined image dynamics for our sensor simulation. The scene appears almost static at the start of a trial for the 250 ft/sec closure rate. There is, however, a noticeable change in the display at a 1000 ft/sec closure rate. Response times decreased absolutely with increasing closure rates. However, stand-off ranges were much longer for the slower closure rates. With respect to target size, it is clear that the targets were suprathreshold. We are left with an interesting question regarding recognition performance. Why, at the higher closure rates, were response times relatively slow resulting in short stand-off ranges? We suspect that the greater relative motion for the 1000 ft/sec closure rate caused the subjects to alter their criteria for response, perhaps due to a motion induced perceptual set.

7.0 REFERENCES

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APPENDIX A

This appendix contains the instructions.

A.1 STUDY INSTRUCTIONS

You have been asked to participate in a dynamic target acquisition study. The displayed scenes you will view simulate those a pilot would see on a display in the aircraft as he approaches a target area. On each trial you are to determine whether a target is present in the scene and, if it is, to identify the target type (tank, half-track, or truck). Your first task, when a target has been detected, will be to move a cross hair over the middle of the target and designate its location by pulling a trigger. When you are sure you can identify the target, a weapon release response should be made by pulling the same trigger to its second position. The final task, identification of the target, concludes the trial. We would like you to respond as rapidly as possible when designating the location of the target and releasing the weapon. However, we also would like you to be very accurate in identifying the target.

We will now detail the study procedures and the response options available to you. On the console there is a TV display with a small red light above it, plus a control stick with a two-position trigger attached to the back and three buttons mounted on the upper face. A three-button, target identification response box is labeled and placed to the left of the control stick. A tone will be heard one second before the start of each trial. A scene then will be presented which changes dynamically to simulate an aircraft approaching a target area at one of three speeds. The position of the control stick determines the position of the cross hair. We recommend you hold the stick in a neutral position at the start of eac ial so that the cross hair appears over the center of the display. Please do not pull the trigger between trials. As soon as a target is detected, you are to move the cross hair over the target and pull the trigger to the first position to designate its location. This initiates target lock-on and automatically reorients the sensor so that the target moves to the center of the display. The trigger pull also removes the cross hair and illuminates the red light above the display. When you are sure you can identify the target, pull the trigger to the second position. This simulates weapon release and terminates the trial by removing the scene from the display. You may pull the trigger through both positions without waiting for the target to center. It is not necessary to hold the trigger at the first position while the target is centered. Once a weapon release (second trigger position) response is made, you are to identify the target type by pressing the appropriate button on the target identification box.

If you decide that the initial target designation response is incorrect, you may terminate target lock-on by pressing the center button located on the upper face of the control stick. This will cause the cross hair to reappear on the display, and you may slew it to a new position on the display to designate target location.

Another response option allows you to return to the sensor line-of-sight that was used at the beginning of the trial. Whenever the cross hair is on the display, you may accomplish this by pushing the button located to the right on the upper face of the control stick. Remember, however, the aircraft will have "zoomed" in on the target area and a smaller (yet magnified) background scene will be displayed than was originally presented.

If the target is present when the trial begins, it will appear in the center two-thirds of the background scene and will move toward the edge of the display as the aircraft closes on the target area. However, on 25% of the trials no target will be present in the scene. For these trials, you are to press the "no target" button located at the left on the upper face of the control stick. It is important to make the "no target" response as soon as you are sure that no target is present in the scene.

When pulling the trigger through both positions and when pushing the "no target" button, speed and accuracy are equally important and should be maximized. Remember, you must also identify the target by pressing the appropriate button on the identification box after the weapon has been released.

Are there any questions?

APPENDIX B

This appendix contains tables of means derived from the analyses of variance for all main effects and second and third order interactions. The appendix also contains tables of Newman-Keuls tests for simple main effects and two-way interactions.

TABLE B-1 Means for Response Time (SEC) to Target Detection - Main Effects for 15,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	2.75
Inactive Target FLIR	3.43
Television Target	4.31
Scene Complexity	
Low	2.64
Medium	3.92
High	3.80
Speed (FT/SEC)	
250	3.63
500	3.63
1000	3.12
Target Type	
Tank	3.59
Half-Track	3.54
Truck	3.27
Subject	
1	2.12
2	4.53
3	2.40
4	3.28
5	3.72
6	4.49

TABLE B-2 Means for Response Time (SEC) to Target Detection - Two-Way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity			
	Low	Medium	High
Active Target FLIR	2.22	3.20	2.79
Inactive Target FLIR	2.82	4.12	3.26
Television Target	2.86	4.42	6.17
Signature X Speed (FT/SEC)			
	250	500	1000
Active Target FLIR	3.29	2.20	2.77
Inactive Target FLIR	2.95	4.69	2.94
Television Target	4.70	4.28	3.83
Signature X Target Type			
	Tank	Half-Track	Truck
Active Target FLIR	2.46	2.97	2.88
Inactive Target FLIR	3.44	3.27	3.56
Television Target	5.22	4.61	3.38
Scene Complexity X Speed (FT/SEC)			
	250	500	1000
Low	2.44	2.82	2.70
Medium	4.31	4.08	3.34
High	4.13	3.87	3.34

TABLE B-2 Means For Response Time (SEC) to Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type			
	Tank	Half-Track	Truck
Low	2.61	2.68	2.63
Medium	4.03	4.05	3.71
High	4.18	3.91	3.40
Speed (FT/SEC) X Target Type			
	Tank	Half-track	Truck
250	3.66	3.73	3.48
500	3.58	3.69	3.63
1000	3.53	3.14	2.72

TABLE B-3 Means for Response Time (SEC) to Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	350	500	1000
Active Target FLIR	2.12	1.99	2.44	4.20	2.37	3.18	3.43	2.15	2.78
Inactive Target FLIR	2.25	3.38	2.98	3.59	6.10	2.92	3.00	4.38	2.91
Television Target	2.91	2.90	2.77	5.21	4.09	3.97	6.19	6.81	5.41

Signature X Scene Complexity X Target Type	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	2.32	2.27	2.07	2.77	2.77	4.03	2.26	3.66	2.48
Inactive Target FLIR	2.52	2.59	3.44	4.66	4.35	3.38	3.22	2.54	3.88
Television Target	3.07	3.17	2.44	4.83	4.81	3.73	8.52	8.01	3.97

TABLE B-3 Means for Response Time (SEC) to Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES — MEAN

Signature X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	2.27	3.46	4.57	2.05	2.11	2.40	3.00	3.19	2.22
Inactive Target FLIR	3.45	2.79	2.60	3.88	5.41	4.99	3.06	2.42	3.31
Television Target	5.72	5.06	3.59	4.94	4.04	3.82	4.99	4.40	2.73

Scene Complexity X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	2.50	2.56	2.23	2.78	2.52	3.06	2.58	2.95	2.62
Medium	4.64	3.53	4.80	3.23	4.91	4.09	4.27	3.51	2.37
High	4.03	5.08	3.28	4.96	2.20	3.63	3.65	3.02	3.27

TABLE B-4 Newman-Keuls Test for Response Time (SEC) to Target Detection - Main Effects for 15,000 Ft Initial Slant Range

Signature

ORDERED MEANS	2.75	3.43	4.31
2.75		*	*
3.43			*
4.31			

Speed

ORDERED MEANS	3.12	3.63	3.63
3.12		*	*
3.63			
3.63			

Scene Complexity

ORDERED MEANS	2.64	3.80	3.92
2.64		*	*
3.80			
3.92			

Target Type

ORDERED MEANS	3.27	3.54	3.59
3.27			*
3.54			
3.59			

*$p < .05$

TABLE B-5 Newman-Keuls Tests for Response Time (SEC) to Target Detection - Two-way Interactions for 15,000 Ft. Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	2.22	2.79	2.82	2.86	3.20	3.26	4.12	4.42	6.17
2.22					*	*	*	*	*
2.79							*	*	*
2.82							*	*	*
2.86							*	*	*
3.20							*	*	*
3.26							*	*	*
4.12									*
4.42									*
6.17									

Signature X Speed

ORDERED MEANS	2.20	2.77	2.94	2.95	3.29	3.83	4.28	4.69	4.70
2.20			*		*	*	*	*	*
2.77						*	*	*	*
2.94						*	*	*	*
2.95						*	*	*	*
3.29							*	*	*
3.83								*	*
4.28									
4.69									
4.70									

*$p < .05$

TABLE B-5 Newman-Keuls Test for Response Time (SEC) to Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	2.46	2.88	2.97	3.27	3.38	3.44	3.56	4.61	5.22
2.46				*	*	*	*	*	*
2.88								*	*
2.97								*	*
3.27								*	*
3.38								*	*
3.44								*	*
3.56									*
4.61									*
5.22									

Scene Complexity X Speed

NS

*p<.05

TABLE B-5 Newman-Keuls Test for Response Time (SEC) to Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	2.61	2.63	2.68	3.40	3.71	3.91	4.03	4.05	4.18
2.61					*	*	*	*	*
2.63				*	*	*	*	*	*
2.68				*	*	*	*	*	*
3.40									
3.71									
3.91									
4.03									
4.05									
4.18									

Speed X Target Type

NS

*p< .05

TABLE B-6 Means for Response Time (SEC) to Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	3.77
Inactive Target FLIR	4.64
Television Target	5.31
Scene Complexity	
Low	4.35
Medium	4.75
High	4.52
Speed (FT/SEC)	
250	5.00
500	4.70
1000	3.90
Target Type	
Tank	4.67
Half-Track	4.82
Truck	4.20
Subject	
1	2.27
2	5.81
3	3.41
4	5.77
5	4.16
6	5.56

TABLE B-7 Means for Response Time (SEC) to Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	3.87	3.82	3.64
Inactive Target FLIR	4.60	5.36	3.81
Television Target	4.54	5.01	6.88
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	5.16	2.79	3.38
Inactive Target FLIR	3.89	6.64	3.84
Television Target	6.03	5.09	4.65
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	3.13	4.48	3.83
Inactive Target FLIR	4.62	4.35	4.93
Television Target	6.69	5.83	3.87
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	3.94	5.06	4.17
Medium	5.92	4.58	3.68
High	5.13	4.47	3.84

TABLE B-7 Means for Response Time (SEC) to Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Truck	Truck
Low	3.79	5.08	4.27
Medium	5.05	4.73	4.46
High	5.21	4.61	3.85

Speed (FT/SEC) X Target Type	Tank	Half-Truck	Truck
250	5.65	4.46	4.90
500	4.11	6.05	4.33
1000	4.19	4.20	3.41

TABLE B-8 Means for Response Time (SEC) to Recognition - Three - way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	4.60	3.80	3.36	5.54	2.54	3.63	5.29	2.41	3.20
Inactive Target FLIR	2.34	6.63	5.46	5.74	7.26	3.27	3.56	5.63	3.04
Television Target	5.08	4.49	3.91	6.50	4.39	4.18	6.60	7.41	6.82
Signature X Scene Complexity X Target Type									
	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	2.73	4.86	4.27	2.95	3.65	4.94	3.66	4.82	2.51
Inactive Target FLIR	3.51	4.76	5.84	6.38	5.19	4.56	4.03	2.70	4.49
Television Target	5.36	5.61	2.97	6.09	5.15	3.94	9.25	8.46	4.76

TABLE B-8 Means for Response Time (SEC) to Recognition - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature Speed (FT/SEC) Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	3.71	4.47	8.33	2.41	3.75	2.42	3.18	5.22	2.25
Inactive Target FLIR	5.08	3.25	3.40	4.68	8.56	7.24	4.11	2.88	4.51
Television Target	8.83	5.81	4.05	5.38	6.52	3.92	5.82	5.00	3.66
Scene Complexity Speed (FT/SEC) Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	3.85	3.33	4.80	3.23	8.46	4.60	4.28	4.79	3.55
Medium	7.46	4.26	6.15	3.27	5.79	4.69	4.57	3.83	2.75
High	5.87	5.78	3.81	6.21	2.76	3.73	3.67	3.81	4.03

TABLE B-9 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

Signature

ORDERED MEANS	3.77	4.64	5.31
3.77		*	*
4.64			*
5.31			

Speed

ORDERED MEANS	3.90	4.70	5.00
3.90		*	*
4.70			
5.00			

Scene Complexity

NS

Target Type

NS

*p<.05

TABLE B-10 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	3.64	3.81	3.82	3.87	4.54	4.60	5.01	5.36	6.88
3.64								*	*
3.81									*
3.82									*
3.87									*
4.54									*
4.60									*
5.01									*
5.36									*
6.88									

Signature X Speed

ORDERED MEANS	2.79	3.38	3.84	3.89	4.65	5.09	5.16	6.03	6.64
2.79					*	*	*	*	*
3.38						*	*	*	*
3.84								*	*
3.89									*
4.65									*
5.09									*
5.16									*
6.03									
6.64									

*$p < .05$

TABLE B-10 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	3.13	3.83	3.87	4.35	4.48	4.62	4.93	5.83	6.69
3.13							*	*	*
3.83								*	*
3.87								*	*
4.35								*	*
4.48									*
4.62									*
4.93									*
5.83									
6.69									

Scene Complexity X Speed

ORDERED MEANS	3.68	3.84	3.94	4.17	4.47	4.58	5.06	5.13	5.92
3.68									*
3.84									*
3.94									*
4.17									*
4.47									*
4.58									
5.06									
5.13									
5.92									

*$p < .05$

TABLE B-10 Newman-Keuls Tests for Response Time (SEC) to Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	3.79	3.85	4.27	4.46	4.61	4.73	5.05	5.08	5.21
3.79									*
3.85									
4.27									
4.46									
4.61									
4.73									
5.05									
5.08									
5.21									

Speed X Target Type

ORDERED MEANS	3.41	4.11	4.19	4.20	4.33	4.46	4.90	5.65	6.05
3.41								*	*
4.11									*
4.19									*
4.20									*
4.33									*
4.46									*
4.90									
5.65									
6.05									

*$p < .05$

TABLE B-11 Means for Range (FT) at Target Detection - Main Effects for 15,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	13420
Inactive Target FLIR	13063
Television Target	12732
Scene Complexity	
Low	13438
Medium	12873
High	12958
Speed (FT/SEC)	
250	14093
500	13186
1000	11879
Target Type	
Tank	12933
Half-Track	13154
Truck	13178
Subject	
1	13748
2	12504
3	13498
4	13347
5	12970
6	12541

TABLE B-12 Means for Range (FT) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity			
	Low	Medium	High
Active Target FLIR	13552	13264	13453
Inactive Target FLIR	13357	12768	13093
Television Target	13413	12606	11965
Signature X Speed (FT/SEC)			
	250	500	1000
Active Target FLIR	14178	13900	12233
Inactive Target FLIR	14264	12654	12065
Television Target	13825	12859	11173
Signature X Target Type			
	Tank	Half-Track	Truck
Active Target FLIR	13449	13374	13431
Inactive Target FLIR	13046	13234	12921
Television Target	12147	12775	13173
Scene Complexity X Speed (FT/SEC)			
	250	500	1000
Low	14389	13592	12296
Medium	13923	12961	11657
High	13967	13064	11660

TABLE B-12 Means for Range (FT) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES — MEAN

Scene Complexity X Target Type

	Tank	Half-Track	Truck
Low	13526	13420	13361
Medium	12629	12882	13105
High	12625	13194	13087

Speed (FT/SEC) X Target Type

	Tank	Half-Track	Truck
250	14084	14068	14129
500	13209	13153	13186
1000	11469	11860	12277

TABLE B-13 Means for Range (FT) at Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	11469	14005	12561	13950	13813	11823	14142	13924	12225
Inactive Target FLIR	14437	13310	12016	14102	11949	12078	14251	12811	12094
Television Target	14273	12549	12234	13698	12953	11027	13454	11596	9590

Signature X Scene Complexity X Target Type	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	13567	13497	13586	13061	13669	13162	13733	13055	13549
Inactive Target FLIR	13537	13596	12887	12558	12768	12965	12972	13474	12901
Television Target	13467	13173	13567	12214	12328	13187	10370	13997	12740

TABLE B-13 Means for Range (FT) at Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	14433	14134	13858	13974	13947	13801	11999	11808	12776
Inactive Target FLIR	14137	14303	14349	13061	12295	12504	11941	12579	11691
Television Target	13571	13735	14103	12530	12980	13091	10007	10598	12267
Scene Complexity X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	14375	14359	14443	13609	13738	13469	12424	12053	12382
Medium	13841	14117	13800	13383	12546	12954	10734	11491	12631
High	13994	13729	14181	12519	13898	13186	11348	11984	11733

TABLE B-14 Newman-Keuls Test for Range (FT) at Target Detection - Main Effects for 15,000 Ft Initial Slant Range

Signature

ORDERED MEANS	12732	13063	13420
12732		*	*
13063			*
13420			

Speed

ORDERED MEANS	11879	13186	14093
11879		*	*
13186			*
14093			

Scene Complexity

ORDERED MEANS	12873	12958	13438
12873			*
12958			*
13438			

Target Type

ORDERED MEANS	12933	13154	13178
12933		*	*
13154			
13178			

p .05

TABLE B-15 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range

ignature X Scene Complexity

ORDERED MEANS	11965	12606	12768	13093	13264	13357	13413	13453	13552
11965		*	*	*	*	*	*	*	*
12606				*	*	*	*	*	*
12768					*	*	*	*	*
13093									
13264									
13357									
13413									
13453									
13552									

Signature X Speed

ORDERED MEANS	11173	12065	12233	12654	12859	13825	13900	14178	14264
11173		*	*	*	*	*	*	*	*
12065				*	*	*	*	*	*
12233				*	*	*	*	*	*
12654						*	*	*	*
12859						*	*	*	*
13825									
13900									
14178									
14264									

*p <.05

TABLE B-15 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	12147	12775	12921	13046	13173	13234	13374	13431	13449
12147		*	*	*	*	*	*	*	*
12775							*	*	*
12921								*	*
13046									
13173									
13234									
13374									
13431									
13449									

Scene Complexity X Speed

NS

*p < .05

TABLE B-15 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Analysis for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	12625	12629	12882	13087	13105	13194	13361	13420	13526
12625				*		*	*	*	*
12629				*	*	*	*	*	*
12882								*	*
13087									
13105									
13194									
13361									
13420									
13526									

Speed X Target Type

ORDERED MEANS	11469	11860	12277	13153	13186	13209	14068	14084	14129
11469		*	*	*	*	*	*	*	*
11860			*	*	*	*	*	*	*
12277				*	*	*	*	*	*
13153							*	*	*
13186							*	*	*
13209							*	*	*
14068									
14084									
14129									

*$p < .05$

TABLE B-16 Means for Range (FT) at Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	12960
Inactive Target FLIR	12390
Television Target	12233
Scene Complexity	
Low	12472
Medium	12543
High	12615
Speed (FT/SEC)	
250	13751
500	12651
1000	11103
Target Type	
Tank	12458
Half-Track	12435
Truck	12713
Subject	
1	13624
2	11876
3	12878
4	12325
5	12723
6	11913

TABLE B-17 Means for Range (FT) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	12735	12989	13117
Inactive Target FLIR	12099	12281	12850
Television Target	12604	12384	11481
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	13709	13607	11620
Inactive Target FLIR	14027	11678	11156
Television Target	13493	12457	10350
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	13208	12412	13182
Inactive Target FLIR	12413	12660	12115
Television Target	11558	12181	12810
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	14015	12468	10833
Medium	13519	12709	11321
High	13719	12768	11161

TABLE B-17 Means for Range (FT) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Track	Truck
Low	12798	11986	12569
Medium	12295	12567	12766
High	12267	12802	12789
Speed (FT/SEC) X Target Type	Tank	Half-Track	Truck
250	13588	13886	13774
500	12947	11976	12838
1000	10811	10801	11595

TABLE B-18 Means for Range (FT) at Target Recognition - Three-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES — MEAN

Signature X Scene Complexity X Speed (FT/SEC)

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	13850	13101	11643	13616	13728	11367	13678	13795	11805
Inactive Target FLIR	14414	11683	9539	13566	11369	11726	14109	12187	11965
Television Target	13729	12755	11086	13376	12806	10819	13351	11293	8185

Signature X Scene Complexity X Target Type

	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	13389	11617	13026	12893	13204	12923	13364	12414	13533
Inactive Target FLIR	12552	12360	11256	12121	12443	12271	12570	13317	12739
Television Target	12439	11955	13273	11798	12156	13094	10087	12885	12000

TABLE B-18 Means for Range (FT) at Target Recognition - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES — MEAN

Signature X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	14073	13883	12919	13794	13125	13789	11823	9775	12750
Inactive Target FLIR	13731	14189	14151	12661	10719	11380	10892	12119	10492
Television Target	12793	13548	13989	12310	11739	13043	9177	9998	11345

Scene Complexity X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	14038	14168	13799	13383	10769	12700	10723	10206	11447
Medium	13135	13934	13463	13367	12105	12654	10433	11169	12252
High	13532	13555	14047	11894	13622	13134	11327	11191	10973

TABLE B-19 Newman-Keuls Test for Range (FT) at Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

Signature

ORDERED MEANS	12233	12390	12960
12233			*
12390			*
12960			

Speed

ORDERED MEANS	11103	12651	13751
11103		*	*
12651			*
13751			

Scene Complexity

NS

Target Type

ORDERED MEANS	12435	12458	12713
12435			*
12458			
12713			

*$p < .05$

TABLE B-20 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	11481	12099	12281	12384	12604	12735	12850	12989	13117
11481		*	*	*	*	*	*	*	*
12099								*	*
12281									*
12384									
12604									
12735									
12850									
12989									
13117									

Signature X Speed

ORDERED MEANS	10350	11156	11620	11678	12457	13493	13607	13709	14027
10350		*	*	*	*	*	*	*	*
11156					*	*	*	*	*
11620					*	*	*	*	*
11678					*	*	*	*	*
12457						*	*	*	*
13493									
13607									
13709									
14027									

*p < .05

TABLE B-20 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	11558	12115	12181	12412	12413	12660	12810	13182	13208
11558			*	*	*	*	*	*	*
12115								*	*
12181								*	*
12412								*	*
12413								*	*
12660									
12810									
13182									
13208									

Scene Complexity X Speed

NS

*$p < .05$

TABLE B-20 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

NS

Speed X Target Type

ORDERED MEANS	10801	10811	11595	11976	12838	12947	13588	13774	13886
10801			*	*	*	*	*	*	*
10811			*	*	*	*	*	*	*
11595					*	*	*	*	*
11976					*	*	*	*	*
12838							*	*	*
12947							*	*	*
13588									
13774									
13886									

*$p < .05$

TABLE B-21 Mean Target Width (IN) at Target Detection - Main Effects for 15,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	0.211
Inactive Target FLIR	0.211
Television Target	0.219
Scene Complexity	
Low	0.190
Medium	0.223
High	0.220
Speed (FT/SEC)	
250	0.195
500	0.212
1000	0.235
Target Type	
Tank	0.237
Half-Track	0.190
Truck	0.211
Subject	
1	0.204
2	0.228
3	0.203
4	0.207
5	0.215
6	0.221

TABLE B-22 Mean Target Width (IN) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	0.196	0.227	0.209
Inactive Target FLIR	0.190	0.226	0.216
Television Target	0.188	0.233	0.244
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	0.199	0.212	0.221
Inactive Target FLIR	0.196	0.206	0.231
Television Target	0.189	0.218	0.253
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	0.225	0.191	0.213
Inactive Target FLIR	0.227	0.182	0.222
Television Target	0.263	0.195	0.199
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	0.181	0.190	0.202
Medium	0.207	0.223	0.258
High	0.197	0.221	0.246

TABLE B-22 Mean Target Width (IN) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type			
	Tank	Half-Track	Truck
Low	0.206	0.169	0.193
Medium	0.252	0.205	0.226
High	0.253	0.191	0.211
Speed (FT/SEC) X Target Type			
	Tank	Half-Track	Truck
250	0.210	0.181	0.194
500	0.228	0.189	0.214
1000	0.273	0.200	0.224

TABLE B-23 Mean Target Width (IN) at Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES — MEAN

Signature X Scene Complexity X Speed (FT/SEC)

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	0.178	0.209	0.203	0.221	0.215	0.250	0.197	0.212	0.217
Inactive Target FLIR	0.191	0.183	0.194	0.196	0.227	0.257	0.202	0.205	0.235
Television Target	0.172	0.181	0.207	0.205	0.229	0.268	0.192	0.255	0.327

Signature X Scene Complexity X Target Type

	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.205	0.177	0.205	0.245	0.200	0.229	0.224	0.196	0.206
Inactive Target FLIR	0.207	0.156	0.202	0.245	0.199	0.235	0.231	0.187	0.224
Television Target	0.207	0.175	0.176	0.268	0.217	0.215	0.328	0.186	0.204

TABLE B-23 Mean Target Width (IN) at Target Detection - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.207	0.192	0.197	0.222	0.191	0.220	0.246	0.191	0.218
Inactive Target FLIR	0.218	0.173	0.199	0.214	0.181	0.216	0.246	0.192	0.252
Television Target	0.204	0.178	0.187	0.248	0.194	0.206	0.352	0.230	0.204
Scene Complexity X Speed (FT/SEC) X Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	0.200	0.166	0.174	0.206	0.155	0.197	0.214	0.184	0.206
Medium	0.222	0.189	0.209	0.232	0.207	0.232	0.301	0.229	0.235
High	0.209	0.189	0.196	0.249	0.194	0.210	0.301	0.193	0.229

TABLE B-24 Newman-Keuls Test for Target Width (IN) at Target Detection - Main Effects for 15,000 Ft Initial Slant Range

Signature

ORDERED MEANS	0.211	0.211	0.219
0.211			*
0.211			*
0.219			

Speed

ORDERED MEANS	0.195	0.212	0.235
0.195		*	*
0.212			*
0.235			

Scene Complexity

ORDERED MEANS	0.190	0.220	0.223
0.190		*	*
0.220			
0.223			

Target Type

ORDERED MEANS	0.190	0.211	0.237
0.190		*	*
0.211			*
0.237			

*p < .05

TABLE B-25 Newman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	0.188	0.190	0.196	0.209	0.216	0.226	0.227	0.233	0.244
0.188				*	*	*	*	*	*
0.190				*	*	*	*	*	*
0.196					*	*	*	*	*
0.209						*	*	*	*
0.216									*
0.226									*
0.227									*
0.233									*
0.244									

Signature X Speed

ORDERED MEANS	0.189	0.196	0.199	0.206	0.212	0.218	0.221	0.231	0.258
0.189					*	*	*	*	*
0.196						*	*	*	*
0.199						*	*	*	*
0.206								*	*
0.212								*	*
0.218									*
0.221									*
0.231									*
0.258									

*$p < .05$

TABLE B-25 Neman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	0.182	0.191	0.195	0.199	0.213	0.222	0.225	0.227	0.263
0.182					*	*	*	*	*
0.191					*	*	*	*	*
0.195					*	*	*	*	*
0.199						*	*	*	*
0.213									*
0.222									*
0.225									*
0.227									*
0.263									

Scene Complexity X Speed

ORDERED MEANS	0.181	0.190	0.197	0.202	0.207	0.221	0.223	0.246	0.258
0.181				*	*	*	*	*	*
0.190						*	*	*	*
0.197						*	*	*	*
0.202						*	*	*	*
0.207						*		*	*
0.221								*	*
0.223								*	*
0.246									
0.258									

*p · .05

TABLE B-25 Newman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	0.169	0.191	0.193	0.205	0.206	0.211	0.226	0.252	0.253
0.169		*	*	*	*	*	*	*	*
0.191						*	*	*	*
0.193						*	*	*	*
0.205							*	*	*
0.206							*	*	*
0.211							*	*	*
0.226								*	*
0.252									
0.253									

Speed X Target Type

ORDERED MEANS	0.181	0.189	0.194	0.200	0.210	0.214	0.224	0.228	0.273
0.181				*	*	*	*	*	*
0.189				*	*	*	*	*	*
0.194						*	*	*	*
0.200							*	*	*
0.210								*	*
0.214									*
0.224									*
0.228									*
0.273									

*p < .05

TABLE B-26 Means for Target Width (IN) at Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

VARIABLES	MEAN
Signature	
Active Target FLIR	0.221
Inactive Target FLIR	0.227
Television Target	0.232
Scene Complexity	
Low	0.213
Medium	0.237
High	0.228
Speed (FT/SEC)	
250	0.201
500	0.225
1000	0.255
Target Type	
Tank	0.249
Half-Track	0.203
Truck	0.223
Subject	
1	0.207
2	0.243
3	0.215
4	0.231
5	0.220
6	0.238

TABLE B-27 Means for Target Width (IN) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	0.214	0.233	0.215
Inactive Target FLIR	0.219	0.239	0.221
Television Target	0.205	0.238	0.258
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	0.208	0.219	0.235
Inactive Target FLIR	0.200	0.230	0.254
Television Target	0.196	0.227	0.284
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	0.230	0.212	0.218
Inactive Target FLIR	0.242	0.191	0.246
Television Target	0.281	0.207	0.208
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	0.187	0.215	0.239
Medium	0.215	0.230	0.269
High	0.212	0.228	0.259

TABLE B-27 Means for Target Width (IN) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Track	Truck
Low	0.226	0.197	0.213
Medium	0.261	0.211	0.236
High	0.260	0.199	0.220
Speed (FT/SEC) X Target Type	Tank	Half-Track	Truck
250	0.220	0.184	0.201
500	0.234	0.212	0.225
1000	0.294	0.222	0.243

TABLE B-28 Means for Target Width (IN) at Target Recognition - Three-way Interactions for 15,000 Ft Initial Slant Range

VARIABLES — **MEAN**

Signature X Scene Complexity X Speed

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	0.191	0.229	0.223	0.227	0.216	0.262	0.205	0.214	0.226
Inactive Target FLIR	0.192	0.221	0.253	0.205	0.244	0.271	0.204	0.219	0.238
Television Target	0.180	0.197	0.244	0.213	0.232	0.274	0.194	0.263	0.372

Signature X Scene Complexity X Target Type

	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.208	0.220	0.216	0.250	0.209	0.234	0.230	0.208	0.206
Inactive Target FLIR	0.233	0.174	0.248	0.254	0.205	0.260	0.240	0.190	0.227
Television Target	0.240	0.200	0.182	0.280	0.220	0.217	0.335	0.188	0.227

TABLE B-28 Means for Target Width (IN) at Target Recognition - Three-way Interactions for 15,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.214	0.196	0.216	0.225	0.209	0.220	0.252	0.236	0.218
Inactive Target FLIR	0.225	0.175	0.203	0.223	0.207	0.253	0.274	0.200	0.287
Television Target	0.221	0.181	0.189	0.253	0.220	0.207	0.387	0.243	0.230
Scene Complexity X Speed (FT/SEC) X Target Type	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	0.206	0.169	0.187	0.210	0.212	0.223	0.268	0.222	0.227
Medium	0.238	0.191	0.216	0.232	0.216	0.242	0.311	0.236	0.249
High	0.217	0.191	0.198	0.263	0.199	0.211	0.302	0.210	0.253

TABLE B-29 Newman-Keuls Test for Target Width (IN) at Target Recognition - Main Effects for 15,000 Ft Initial Slant Range

Signature

NS

Speed

ORDERED MEANS	0.201	0.225	0.255
0.201		*	*
0.225			*
0.255			

Scene Complexity

ORDERED MEANS	0.213	0.228	0.237
0.213		*	*
0.228			*
0.237			

Target Type

ORDERED MEANS	0.203	0.223	0.249
0.203		*	*
0.223			*
0.249			

*p < .05

TABLE B-30 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	0.205	0.214	0.215	0.219	0.221	0.233	0.238	0.239	0.258
0.205						*	*	*	*
0.214							*	*	*
0.215							*	*	*
0.219									*
0.221									*
0.233									*
0.238									*
0.239									*
0.258									

Signature X Speed

ORDERED MEANS	0.196	0.200	0.208	0.219	0.227	0.230	0.235	0.254	0.284
0.196				*	*	*	*	*	*
0.200				*	*	*	*	*	*
0.208					*	*	*	*	*
0.219								*	*
0.227								*	*
0.230								*	*
0.235								*	*
0.254									*
0.284									

*$p < .05$

TABLE B-30 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	0.191	0.207	0.208	0.212	0.218	0.230	0.242	0.246	0.281
0.191		*		*	*	*	*	*	*
0.207						*	*	*	*
0.208						*	*	*	*
0.212							*	*	*
0.218							*	*	*
0.230									*
0.242									*
0.246									*
0.281									

Scene Complexity X Speed

NS

*$p < .05$

TABLE B-30 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 15,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	0.197	0.199	0.211	0.213	0.220	0.226	0.236	0.260	0.261
0.197					*	*	*	*	*
0.199						*	*	*	*
0.211						*	*	*	*
0.213							*	*	*
0.220							*	*	*
0.226								*	*
0.236								*	*
0.260									
0.261									

Speed X Target Type

ORDERED MEANS	0.184	0.201	0.212	0.220	0.222	0.225	0.234	0.243	0.294
0.184		*	*	*	*	*	*	*	*
0.201				*	*	*	*	*	*
0.212							*	*	*
0.220								*	*
0.222								*	*
0.225									*
0.234									*
0.243									*
0.294									

*p · .05

TABLE B-31 Means for Response Time (SEC) to Target Detection - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	6.82
Inactive Target FLIR	10.72
Television Target	11.44
Scene Complexity	
Low	3.88
Medium	11.94
High	13.57
Speed (FT/SEC)	
250	11.15
500	9.63
1000	8.19
Target Type	
Tank	9.71
Half-Track	9.88
Truck	9.26
Subject	
1	8.95
2	4.64
3	13.77
4	9.38
5	7.61
6	11.01

TABLE B-32 Means for Response Time (SEC) to Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	3.71	8.83	8.12
Inactive Target FLIR	3.80	13.25	15.18
Television Target	4.13	13.51	19.93
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	9.10	4.98	7.10
Inactive Target FLIR	9.92	15.09	8.33
Television Target	14.48	10.53	9.38
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	5.74	9.92	5.82
Inactive Target FLIR	12.29	6.77	12.67
Television Target	11.90	15.12	9.21
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	3.89	3.93	3.82
Medium	14.60	11.86	10.07
High	16.91	14.02	10.50

TABLE B-32 Means for Response Time (SEC) to Target Detection - Two-Way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type			
	Tank	Half-Track	Truck
Low	3.73	4.69	3.51
Medium	14.25	9.68	11.64
High	13.18	15.98	12.52
Speed (FT/SEC) X Target Type			
	Tank	Half-Track	Truck
250	11.94	12.88	8.66
500	9.01	8.54	10.80
1000	8.66	7.50	8.16

TABLE B-33 Means for Response Time (SEC) to Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES — MEAN

Signature X Scene Complexity X Speed (FT/SEC)

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	3.52	4.42	3.34	10.99	5.80	12.89	14.46	4.44	7.37
Inactive Target FLIR	3.44	4.15	3.93	9.91	25.26	7.82	17.39	18.78	11.59
Television Target	4.82	3.41	4.34	21.82	9.48	10.95	18.73	27.75	14.58

Signature X Scene Complexity X Target Type

	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	3.31	5.45	2.98	8.72	8.80	9.03	5.93	15.63	5.94
Inactive Target FLIR	3.74	4.09	3.64	20.00	8.30	13.52	16.86	7.39	20.10
Television	4.16	4.59	3.85	15.84	13.02	11.63	19.95	40.42	13.08

TABLE B-33 Means for Response Time (SEC) to Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES — MEAN

Signature X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	8.36	12.51	6.68	4.15	6.32	5.04	5.07	11.44	6.16
Inactive Target FLIR	14.33	6.43	9.32	15.18	11.53	16.93	8.74	4.70	11.76
Television Target	14.64	20.77	9.06	10.41	8.82	11.23	11.93	7.48	7.03

Scene Complexity X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	4.04	4.48	3.10	2.97	6.13	3.56	4.11	3.34	3.80
Medium	21.96	8.60	16.48	11.25	11.23	12.80	12.75	9.38	8.15
High	19.70	26.42	9.08	13.57	6.83	16.13	9.60	8.99	12.88

TABLE B-34 Newman-Keuls Test for Response Time (SEC) to Target Detection - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	6.82	10.72	11.44
6.82		*	*
10.72			
11.44			

Speed

ORDERED MEANS	8.19	9.63	11.15
8.19			*
9.63			*
11.15			

Scene Complexity

ORDERED MEANS	3.88	11.94	13.57
3.88		*	*
11.94			*
13.57			

Target Type

NS

*p < .05

TABLE B-35 Newman-Keuls Tests for Response Time (SEC) to Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	3.71	3.80	4.13	8.12	8.83	13.25	13.51	15.18	19.93
3.71			*	*	*	*	*	*	*
3.80			*	*	*	*	*	*	*
4.13			*	*	*	*	*	*	*
8.12						*	*	*	*
8.83						*	*	*	*
13.25									*
13.51									*
15.18									*
19.93									

Signature X Speed

ORDERED MEANS	4.98	7.10	8.33	9.10	9.38	9.92	10.53	14.48	15.09
4.98			*	*	*	*	*	*	*
7.10								*	*
8.33								*	*
9.10								*	*
9.38								*	*
9.92								*	*
10.53								*	*
14.48									
15.09									

*p .05

TABLE B-35 Newman-Keuls Test for Response Time (SEC) to Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	5.74	5.82	6.77	9.21	9.92	11.90	12.29	12.67	15.12
5.74				*	*	*	*	*	*
5.82				*	*	*	*	*	*
6.77					*	*	*	*	*
9.21									*
9.92									*
11.90									
12.29									
12.67									
15.12									

Scene Complexity X Speed

ORDERED MEANS	3.82	3.89	3.93	10.07	10.50	11.86	14.02	14.60	16.91
3.82				*	*	*	*	*	*
3.89				*	*	*	*	*	*
3.93				*	*	*	*	*	*
10.07							*	*	*
10.50							*	*	*
11.86									*
14.02									
14.60									
16.91									

*$p < .05$

TABLE B-35 Newman-Keuls Test for Response Time (SEC) to Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	3.51	3.73	4.69	9.68	11.64	12.52	13.18	14.25	15.98
3.51				*	*	*	*	*	*
3.73				*	*	*	*	*	*
4.69				*	*	*	*	*	*
9.68							*	*	*
11.64									*
12.52									*
13.18									
14.25									
15.98									

Speed X Target Type

ORDERED MEANS	7.50	8.16	8.54	8.66	8.66	9.01	10.80	11.94	12.88
7.50								*	*
8.16									*
8.54									*
8.66									*
8.66								*	*
9.01									*
10.80									
11.94									
12.88									

*$p < .05$

TABLE B-36 Means for Response Time (SEC) to Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	15.76
Inactive Target FLIR	21.08
Television Target	25.28
Scene Complexity	
Low	18.17
Medium	21.18
High	22.53
Speed (FT/SEC)	
250	27.79
500	20.46
1000	14.31
Target Type	
Tank	18.33
Half-Track	22.21
Truck	21.62
Subject	
1	25.00
2	7.10
3	19.40
4	28.33
5	16.49
6	24.07

TABLE B-37 Means for Response Time (SEC) to Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	11.92	19.06	16.70
Inactive Target FLIR	19.08	21.85	22.34
Television Target	23.39	22.49	32.13
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	22.04	14.73	12.31
Inactive Target FLIR	23.87	26.79	14.48
Television Target	37.65	21.93	16.57
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	14.42	18.66	15.22
Inactive Target FLIR	19.80	17.67	25.28
Television Target	21.53	34.90	24.08
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	21.93	18.57	13.79
Medium	33.03	19.94	13.88
High	30.42	23.68	15.18

TABLE B-37 Means for Response Time (SEC) to Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type			
	Tank	Half-Track	Truck
Low	13.90	21.89	20.85
Medium	22.91	19.83	20.68
High	19.75	25.62	23.22
Speed (FT/SEC) X Target Type			
	Tank	Half-Track	Truck
250	25.02	29.32	29.15
500	16.80	21.49	23.52
1000	14.62	14.64	13.76

TABLE B-38 Means for Response Time (SEC) to Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES — MEAN

Signature X Scene Complexity X Speed (FT/SEC)

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	11.32	17.51	8.29	37.91	12.37	17.02	23.78	15.38	13.43
Inactive Target FLIR	18.88	21.15	16.89	25.37	33.44	12.41	28.47	27.00	15.05
Television Target	36.35	17.27	18.10	37.27	19.45	13.48	39.60	36.54	18.93

Signature X Scene Complexity X Target Type

	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	10.04	13.94	13.05	23.90	15.05	16.76	11.18	27.37	15.88
Inactive Target FLIR	13.35	19.82	25.62	23.79	19.50	22.78	24.47	13.54	27.65
Television Target	18.51	33.42	23.26	21.31	26.35	21.39	27.21	54.92	28.23

TABLE B-38 Means for Response Time (SEC) to Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES — MEAN

Signature X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	20.58	22.82	24.05	13.88	14.54	15.79	8.93	19.44	10.81
Inactive Target FLIR	22.06	23.58	25.83	22.28	22.34	32.66	16.33	9.84	17.35
Television Target	37.25	40.82	35.23	16.47	34.21	23.31	18.21	19.44	13.80

Scene Complexity X Speed (FT/SEC) X Target Type

	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	15.94	23.24	30.54	11.78	25.72	21.24	13.56	15.90	12.84
Medium	43.41	27.59	30.49	18.17	16.44	23.67	15.40	13.26	12.93
High	27.08	37.46	27.51	21.13	25.65	25.78	14.96	14.85	15.73

TABLE B-39 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	15.76	21.08	25.28
15.76		*	*
21.08			*
25.28			

Speed

ORDERED MEANS	14.31	20.46	27.79
14.31		*	*
20.46			*
27.79			

Scene Complexity

ORDERED MEANS	18.17	21.18	22.53
18.17		*	*
21.18			
22.53			

Target Type

ORDERED MEANS	18.33	21.62	22.21
18.33		*	*
21.62			
22.21			

TABLE B-40 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	11.92	16.70	19.06	19.08	21.85	22.34	22.49	23.39	32.13
11.92		*	*	*	*	*	*	*	*
16.70								*	*
19.06									*
19.08									*
21.85									*
22.34									*
22.49									*
23.39									*
32.13									

Signature X Speed

ORDERED MEANS	12.31	14.48	14.73	16.57	21.93	22.04	23.87	26.79	37.65
12.31					*	*	*	*	*
14.48					*	*	*	*	*
14.73					*	*	*	*	*
16.57					*	*	*	*	*
21.93									*
22.04									*
23.87									*
26.79									*
37.65									

*p · .05

TABLE B-40 Newman-Keuls Test for Response Time (SEC) to Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	14.42	15.22	17.67	18.66	19.80	21.53	24.08	25.28	34.90
14.42					*	*	*	*	*
15.22						*	*	*	*
17.67							*	*	*
18.66							*	*	*
19.80								*	*
21.53									*
24.08									*
25.28									*
34.90									

Scene Complexity X Speed

ORDERED MEANS	13.79	13.88	15.18	18.57	19.94	21.93	23.68	30.42	33.03
13.79					*	*	*	*	*
13.88					*	*	*	*	*
15.18						*	*	*	*
18.57								*	*
19.94								*	*
21.93								*	*
23.68								*	*
30.42									
33.03									

*$p < .05$

TABLE B-40 Newman-Keuls Tests for Response Time (SEC) to Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	13.90	19.75	19.83	20.68	20.85	21.89	22.91	23.22	25.62
13.90		*	*	*	*	*	*	*	*
19.75									
19.83									
20.68									
20.85									
21.89									
22.91									
23.22									
25.62									

Speed x Target Type

NS

$^*p < .05$

TABLE B-41 Means for Range (FT) at Target Detection - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	25915
Inactive Target FLIR	23918
Television Target	23936
Scene Complexity	
Low	27743
Medium	23190
High	22521
Speed (FT/SEC)	
250	27212
500	25184
1000	21883
Target Type	
Tank	24402
Half-Track	25062
Truck	24527
Subject	
1	24806
2	26882
3	22560
4	25220
5	24847
6	24245

TABLE B-42 Means for Range (FT) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity			
	Low	Medium	High
Active Target FLIR	27749	24408	25372
Inactive Target FLIR	27844	22329	21430
Television Target	27638	22926	19576
Signature X Speed (FT/SEC)			
	250	500	1000
Active Target FLIR	27726	27508	23004
Inactive Target FLIR	27521	22456	21753
Television Target	26380	24734	20620
Signature X Target Type			
	Tank	Half-Track	Truck
Active Target FLIR	26988	24006	26102
Inactive Target FLIR	23244	26265	22546
Television Target	22467	24547	25000
Scene Complexity X Speed (FT/SEC)			
	250	500	1000
Low	29028	28033	26175
Medium	26349	24069	19934
High	25773	22989	19500

TABLE B-42 Means for Range (FT) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Track	Truck
Low	27873	27562	27714
Medium	21760	24631	23330
High	22399	22700	22529
Speed (FT/SEC) X Target Type	Tank	Half-Track	Truck
250	27014	26780	27836
500	25495	25728	24602
1000	21340	22660	21913

TABLE B-43 Means for Range (FT) AT Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES

MEAN

Signature X Scene Complexity X Speed (FT/SEC)

	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	27976	27117	27953	25360	24614	22964	27280	19873	26675
Inactive Target FLIR	27632	28083	27905	18763	25063	22084	21281	26033	17685
Television Target	27987	27467	27357	20235	23953	24837	15877	19896	22244

Signature X Scene Complexity X Target Type

	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	27976	27117	27953	25360	24614	22964	27280	19873	26675
Inactive Target FLIR	27632	28083	27905	18763	25063	22084	21281	26033	17685
Television Target	27987	27467	27357	20235	23953	24837	15877	19896	22244

TABLE B-43 Means for Range (FT) at Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	27911	26873	28330	27927	26841	27477	24926	19344	23839
Inactive Target FLIR	26417	28392	27669	22409	24236	21534	21261	25304	18729
Television Target	26341	24807	27736	24796	25592	24385	18072	22525	22974
Scene Complexity X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	28989	28881	29225	28516	26936	28221	25889	26722	26133
Medium	24509	27850	25880	24376	24384	23602	17251	20616	21849
High	25076	23395	27730	23214	26587	21935	20398	21009	17118

TABLE B-44 Newman-Keuls Test for Range (FT) at Target Detection - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	23918	23936	25915
23918			*
23936			*
25915			

Speed

ORDERED MEANS	21883	25184	27212
21883		*	*
25184			*
27212			

Scene Complexity

ORDERED MEANS	22521	23190	27743
22521			*
23190			*
27743			

Target Type

NS

*p .05

TABLE B-45 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	19576	21430	22329	22926	24408	25372	27638	27749	27844
19576		*	*	*	*	*	*	*	*
21430					*	*	*	*	*
22329					*	*	*	*	*
22926					*	*	*	*	*
24408							*	*	*
25372							*	*	*
27638									
27749									
27844									

Signature X Speed

ORDERED MEANS	20620	21753	22456	23004	24734	26380	27508	27521	27726
20620			*	*	*	*	*	*	*
21753					*	*	*	*	*
22456					*	*	*	*	*
23004						*	*	*	*
24734						*	*	*	*
26380									
27508									
27521									
27726									

*p < .05

TABLE B-45 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	22467	22546	23244	24006	24547	25000	26102	26265	26988
22467					*	*	*	*	*
22546					*	*	*	*	*
23244						*	*	*	*
24006							*	*	*
24547							*	*	*
25000									*
26102									
26265									
26988									

Scene Complexity X Speed

ORDERED MEANS	19500	19934	22989	24069	25773	26175	26349	28033	29028
19500			*	*	*	*	*	*	*
19934			*	*	*	*	*	*	*
22989					*	*	*	*	*
24069					*	*	*	*	*
25773								*	*
26175								*	*
26349								*	*
28033									
29028									

*p · .05

TABLE B-45 Newman-Keuls Test for Range (FT) at Target Detection - Two-way Analysis for 30,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	21760	22399	22529	22700	23330	24631	27562	27714	27873
21760						*	*	*	*
22399						*	*	*	*
22529						*	*	*	*
22700						*	*	*	*
23330						*	*	*	*
24631							*	*	*
27562									
27714									
27873									

Speed X Target Type

NS

*p · .05

TABLE B-46 Means for Range (FT) at Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	21181
Inactive Target FLIR	18613
Television Target	17723
Scene Complexity	
Low	20256
Medium	19085
High	18220
Speed (FT/SEC)	
250	23053
500	19768
1000	15479
Target Type	
Tank	19928
Half-Track	19069
Truck	18646
Subject	
1	17235
2	25523
3	19761
4	16039
5	20644
6	17575

TABLE B-47 Means for Range (FT) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	22794	20162	20449
Inactive Target FLIR	19643	18079	18076
Television Target	18315	19105	14867
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	24491	22641	17344
Inactive Target FLIR	24033	16604	15226
Television Target	20586	19033	13429
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	22999	18304	21223
Inactive Target FLIR	18581	21394	16281
Television Target	17604	16225	18566
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	24518	20717	15544
Medium	21743	20032	16123
High	22394	18161	14820

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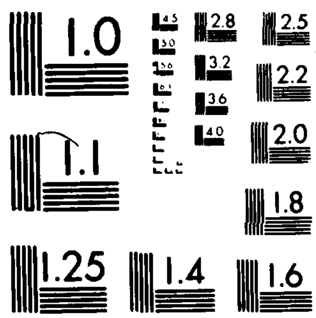

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TABLE B-47 Means for Range (FT) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type			
	Tank	Half-Track	Truck
Low	22427	18304	19016
Medium	18165	20828	18511
High	18355	17688	18410
Speed (FT/SEC) X Target Type			
	Tank	Half-Track	Truck
250	23744	22671	22712
500	21599	19255	18242
1000	15385	14952	15930

TABLE B-48 Means for Range (FT) at Target Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	27170	21244	20578	20523	23816	12978	24055	22311	16566
Inactive Target FLIR	25281	19425	12193	23657	13282	17591	22882	16525	14946
Television Target	20913	21364	11905	20682	20275	16523	20099	11729	11073

Signature X Scene Complexity X Target Type	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	24419	20127	22714	20295	22209	17941	23734	11942	22156
Inactive Target FLIR	21239	20742	16956	15888	20617	17131	17377	22905	14690
Television Target	21423	12981	17844	17611	19445	20299	10802	16271	17447

TABLE B-48 Means for Range (FT) at Target Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	24855	24294	23988	23061	22731	22105	21069	9924	19186
Inactive Target FLIR	24486	24105	23543	18861	18830	13669	13669	20157	11963
Television Target	20688	19795	21193	21767	12896	18343	11795	10565	16195
Scene Complexity X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	26016	24191	22365	24111	17142	19379	16436	12927	16223
Medium	19148	23103	22377	20915	21779	18167	14398	16738	17075
High	23230	20634	23122	19437	17177	17112	15038	15149	14272

TABLE B-49 Newman-Keuls Test for Range (FT) at Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	17723	18613	21181
17723			*
18613			*
21181			

Speed

ORDERED MEANS	15479	19768	23053
15479		*	*
19768			*
23053			

Scene Complexity

ORDERED MEANS	18220	19085	20256
18220			*
19085			*
20256			

Target Type

ORDERED MEANS	18646	19069	19928
18646			*
19069			
19928			

*$p < .05$

TABLE B-50 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	14867	18076	18079	18315	19105	19643	20162	20449	22794
14867		*	*	*	*	*	*	*	*
18076									*
18079									*
18315									*
19105									*
19643									*
20162									*
20449									*
22794									

Signature X Speed

ORDERED MEANS	13429	15226	16604	17344	19033	20586	22641	24033	24491
13429		*	*	*	*	*	*	*	*
15226				*	*	*	*	*	*
16604					*	*	*	*	*
17344					*	*	*	*	*
19033							*	*	*
20586							*	*	*
22641									
24033									
24491									

*$p < .05$

TABLE B-50 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	16225	16281	17604	18304	18566	18581	21223	21394	22999
16225							*	*	*
16281					*		*	*	*
17604							*	*	*
18304							*	*	*
18566							*	*	*
18581								*	*
21223									
21394									
22999									

Scene Complexity X Speed

NS

*p < .05

TABLE B-50 Newman-Keuls Test for Range (FT) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	17688	18165	18304	18355	18410	18511	19016	20828	22427
17688								*	*
18165								*	*
18304								*	*
18355								*	*
18410								*	*
18511								*	*
19016								*	*
20828									
22427									

Speed X Target Type

ORDERED MEANS	14952	15385	15930	18242	19255	21599	22671	22712	23744
14952				*	*	*	*	*	*
15385				*	*	*	*	*	*
15930				*	*	*	*	*	*
18242						*	*	*	*
19255						*	*	*	*
21599									
22671									
22712									
23744									

*p < .05

TABLE B-51 Mean Target Width (IN) at Target Detection - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	0.114
Inactive Target FLIR	0.125
Television Target	0.127
Scene Complexity	
Low	0.094
Medium	0.134
High	0.140
Speed (FT/SEC)	
250	0.103
500	0.117
1000	0.143
Target Type	
Tank	0.133
Half-Track	0.105
Truck	0.122
Subject	
1	0.118
2	0.110
3	0.135
4	0.117
5	0.120
6	0.126

TABLE B-52 Mean Target Width (IN) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	0.098	0.130	0.113
Inactive Target FLIR	0.092	0.136	0.149
Television Target	0.092	0.138	0.166
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	0.103	0.108	0.128
Inactive Target FLIR	0.104	0.123	0.146
Television Target	0.102	0.123	0.157
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	0.114	0.117	0.112
Inactive Target FLIR	0.136	0.094	0.142
Television Target	0.155	0.106	0.111
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	0.092	0.092	0.098
Medium	0.111	0.126	0.160
High	0.110	0.137	0.168

TABLE B-52 Mean Target Width (IN) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Track	Truck
Low	0.100	0.082	0.093
Medium	0.156	0.115	0.131
High	0.155	0.117	0.141
Speed (FT/SEC) X Target Type	Tank	Half-Track	Truck
250	0.113	0.097	0.099
500	0.123	0.098	0.120
1000	0.160	0.118	0.141

TABLE B-53 Mean Target Width (IN) at Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	0.089	0.105	0.098	0.118	0.110	0.177	0.108	0.108	0.127
Inactive Target FLIR	0.097	0.085	0.090	0.100	0.161	0.142	0.114	0.133	0.185
Television Target	0.088	0.086	0.104	0.116	0.122	0.172	0.105	0.198	0.215

Signature X Scene Complexity X Target Type									
	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.100	0.090	0.100	0.132	0.121	0.136	0.113	0.140	0.105
Inactive Target FLIR	0.102	0.073	0.093	0.169	0.107	0.140	0.152	0.097	0.191
Television Target	0.099	0.084	0.089	0.171	0.120	0.116	0.228	0.124	0.134

TABLE B-53 Mean Target Width (IN) at Target Detection - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.099	0.084	0.087	0.099	0.079	0.092	0.104	0.082	0.100
Inactive Target FLIR	0.133	0.095	0.113	0.133	0.114	0.129	0.195	0.143	0.140
Television Target	0.123	0.113	0.101	0.141	0.102	0.141	0.182	0.125	0.187
Scene Complexity X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	0.107	0.103	0.093	0.111	0.099	0.111	0.123	0.146	0.120
Medium	0.121	0.088	0.104	0.132	0.097	0.130	0.150	0.098	0.193
High	0.108	0.104	0.097	0.131	0.097	0.121	0.203	0.123	0.115

TABLE B-54 Newman-Keuls Test for Target Width (IN) at Target Detection - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	0.114	0.125	0.127
0.114		*	*
0.125			*
0.127			

Speed

ORDERED MEANS	0.103	0.117	0.143
0.103		*	*
0.117			*
0.143			

Scene Complexity

ORDERED MEANS	0.094	0.134	0.140
0.094		*	*
0.134			
0.140			

Target Type

ORDERED MEANS	0.105	0.122	0.133
0.105		*	*
0.122			*
0.133			

$^*p < .05$

TABLE B-55 Newman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	0.092	0.092	0.098	0.113	0.130	0.136	0.138	0.149	0.166
0.092					*	*	*	*	*
0.092					*	*	*	*	*
0.098					*	*	*	*	*
0.113								*	*
0.130									*
o.136									*
0.138									*
0.149									
0.166									

Signature X Speed

ORDERED MEANS	0.102	0.103	0.104	0.108	0.123	0.123	0.128	0.146	0.157
0.102								*	*
0.103								*	*
0.104								*	*
0.108								*	*
0.123									*
0.123									*
0.128									*
0.146									
0.157									

*p < .05

TABLE B-55 Newman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Target Type

ORDERED MEANS	0.094	0.106	0.111	0.112	0.114	0.117	0.136	0.142	0.155
0.094								*	*
0.106								*	*
0.111									*
0.112									*
0.114									*
0.117									*
0.136									
0.142									
0.155									

Scene Complexity X Speed

ORDERED MEANS	0.092	0.092	0.098	0.110	0.111	0.126	0.137	0.160	0.168
0.092						*	*	*	*
0.092						*	*	*	*
0.098							*	*	*
0.110								*	*
0.111							*	*	*
0.126								*	*
0.137								*	*
0.160									
0.168									

*p < .05

TABLE B-55 Newman-Keuls Test for Target Width (IN) at Target Detection - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Scene Complexity X Target Type

ORDERED MEANS	0.082	0.093	0.100	0.115	0.117	0.131	0.141	0.155	0.156
0.082				*	*	*	*	*	*
0.093						*	*	*	*
0.100						*	*	*	*
0.115								*	*
0.117								*	*
0.131									
0.141									
0.155									
0.156									

Speed X Target Type

NS

*p < .05

TABLE B-56 Means for Target Width (IN) at Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

VARIABLE	MEAN
Signature	
Active Target FLIR	0.146
Inactive Target FLIR	0.176
Television Target	0.185
Scene Complexity	
Low	0.150
Medium	0.171
High	0.187
Speed (FT/SEC)	
250	0.125
500	0.161
1000	0.213
Target Type	
Tank	0.181
Half-Track	0.155
Truck	0.165
Subject	
1	0.185
2	0.117
3	0.158
4	0.205
5	0.149
6	0.186

TABLE B-57 Means for Target Width (IN) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN		
Signature X Scene Complexity	Low	Medium	High
Active Target FLIR	0.124	0.163	0.153
Inactive Target FLIR	0.153	0.183	0.193
Television Target	0.173	0.165	0.232
Signature X Speed (FT/SEC)	250	500	1000
Active Target FLIR	0.121	0.137	0.174
Inactive Target FLIR	0.123	0.180	0.222
Television Target	0.132	0.174	0.249
Signature X Target Type	Tank	Half-Track	Truck
Active Target FLIR	0.138	0.165	0.141
Inactive Target FLIR	0.195	0.131	0.198
Television	0.218	0.180	0.156
Scene Complexity X Speed (FT/SEC)	250	500	1000
Low	0.112	0.146	0.194
Medium	0.140	0.160	0.204
High	0.128	0.184	0.237

TABLE B-57 Means for Target Width (IN) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN		
Scene Complexity X Target Type	Tank	Half-Track	Truck
Low	0.150	0.148	0.152
Medium	0.198	0.149	0.172
High	0.216	0.170	0.171
Speed (FT/SEC) X Target Type	Tank	Half-Track	Truck
250	0.132	0.120	0.123
500	0.157	0.151	0.171
1000	0.242	0.197	0.191

TABLE B-58 Means for Target Width (IN) at Target Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range

VARIABLES	MEAN								
Signature X Scene Complexity X Speed (FT/SEC)									
	Low			Medium			High		
	250	500	1000	250	500	1000	250	500	1000
Active Target FLIR	0.097	0.150	0.126	0.164	0.128	0.228	0.119	0.139	0.187
Inactive Target FLIR	0.114	0.144	0.223	0.125	0.218	0.197	0.132	0.189	0.246
Television Target	0.126	0.145	0.254	0.140	0.156	0.197	0.133	0.271	0.321

Signature X Scene Complexity X Target Type	Low			Medium			High		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.122	0.122	0.128	0.167	0.145	0.175	0.133	0.231	0.129
Inactive Target FLIR	0.171	0.109	0.168	0.205	0.151	0.198	0.216	0.128	0.226
Television Target	0.160	0.225	0.158	0.196	0.150	0.145	0.353	0.150	0.167

TABLE B-58 Means for Target Width (IN) at Target Recognition - Three-way Interactions for 30,000 Ft Initial Slant Range (Continued)

VARIABLES	MEAN								
Signature X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Active Target FLIR	0.126	0.120	0.112	0.140	0.125	0.143	0.150	0.242	0.152
Inactive Target FLIR	0.133	0.112	0.125	0.172	0.126	0.216	0.261	0.152	0.253
Television Target	0.142	0.130	0.128	0.167	0.238	0.161	0.311	0.245	0.179
Scene Complexity X Speed (FT/SEC) X Target Type									
	250			500			1000		
	Tank	Half-Track	Truck	Tank	Half-Track	Truck	Tank	Half-Track	Truck
Low	0.114	0.103	0.117	0.124	0.167	0.156	0.219	0.181	0.175
Medium	0.170	0.125	0.132	0.162	0.134	0.174	0.226	0.198	0.189
High	0.135	0.131	0.124	0.190	0.160	0.185	0.278	0.209	0.211

TABLE B-59 Newman-Keuls Test for Target Width (IN) at Target Recognition - Main Effects for 30,000 Ft Initial Slant Range

Signature

ORDERED MEANS	0.146	0.176	0.185
0.146		*	*
0.176			*
0.185			

Speed

ORDERED MEANS	0.125	0.161	0.213
0.125		*	*
0.161			*
0.213			

Scene Complexity

ORDERED MEANS	0.150	0.171	0.187
0.150		*	*
0.171			*
0.187			

Target Type

ORDERED MEANS	0.155	0.165	0.181
0.155			*
0.165			*
0.181			

*$p < .05$

TABLE B-60 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range

Signature X Scene Complexity

ORDERED MEANS	0.124	0.153	0.153	0.163	0.165	0.173	0.183	0.193	0.232
0.124		*		*	*	*	*	*	*
0.153								*	*
0.153								*	*
0.163									*
0.165									*
0.173									*
0.183									*
0.193									*
0.232									

Signature X Speed

ORDERED MEANS	0.121	0.123	0.132	0.137	0.174	0.174	0.180	0.222	0.249
0.121					*	*	*	*	*
0.123					*	*	*	*	*
0.132					*	*	*	*	*
0.137					*	*	*	*	*
0.174								*	*
0.174								*	*
0.180								*	*
0.222									*
0.249									

*p < .05

TABLE B-60 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Signature X Scene Complexity
Signature X Speed
Signature X Target Type

ORDERED MEANS	0.131	0.138	0.141	0.156	0.165	0.180	0.195	0.198	0.218
0.131						*	*	*	*
0.138						*	*	*	*
0.141						*	*	*	*
0.156							*	*	*
0.165									*
0.180									*
0.195									
0.198									
0.218									

Scene Complexity X Speed

NS

Scene Complexity X Target Type

NS

*p < .05

TABLE B-60 Newman-Keuls Test for Target Width (IN) at Target Recognition - Two-way Interactions for 30,000 Ft Initial Slant Range (Continued)

Speed X Target Type

ORDERED MEANS	0.120	0.123	0.132	0.151	0.157	0.171	0.191	0.197	0.242
0.120					*	*	*	*	*
0.123						*	*	*	*
0.132						*	*	*	*
0.151							*	*	*
0.157							*	*	*
0.171									*
0.191									*
0.197									*
0.242									

*p $< .05$

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